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PHASE II SUMMARY

INDEPENDENT VERIFICATION AND VALIDATION OF THE
GLOBAL DEPLOYMENT ANALYSIS SYSTEM (GDAS)

Prepared for:

U.S. Army Concepts Analysis Agency
Special Assistant for Model Validation (CSCA-MV)
8120 Woodmont Avenue
Bethesda, Maryland 20814-2797

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Delivery Order Number: 0005
Contract Number: MDA903-89-D-0025
Government Sponsor: U.S. Army Concepts Analysis Agency
Contractor's Project Director: Vernon H. Hamilton
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ABSTRACT

Potomac Systems Engineering, Inc. (PSE), is providing Independent Verification and Validation (IV&V) support to the Special Assistant for Model Validation, U.S. Army Concepts Analysis Agency (CAA), during the design and development of the Global Deployment Analysis System (GDAS). The primary objective of this effort is to help ensure that development of the GDAS results in a model that will perform as intended. This report summarizes the IV&V support provided by PSE during the system implementation phase (Phase II).

Development of the GDAS is a 24-month project, to be executed in three phases by Stanley Associates, Inc., of Alexandria, Virginia. Phase I was a 9-month design phase during which the model developer detailed a specific approach to the GDAS design and prepared a prototype model containing specific features planned for implementation in the final GDAS model. GDAS development is approaching completion of Phase II (implementation) and will end with Phase III (integration, testing, and acceptance).

The IV&V support provided by PSE during Phase I and Phase II contributed to the quality of the GDAS design, documentation, and GDAS software produced to date. A sound IV&V program can ensure that the quality of the model software is established early in the development phase and that this level of quality is maintained and increased as the software is tested, transitioned to the users, and entered into the operations and support phase of the life cycle. It can also promote an efficient design, quality code development, complete functionality, realistic data requirements, run-time efficiencies, and effective human factors engineering.

SECTION 1. INTRODUCTION

1.1 Global Deployment Analysis System (GDAS) Overview

Development of the GDAS is the first step in developing an extensive automated data processing (ADP) system that will evaluate the capabilities and requirements of Department of Defense mobilization and deployment systems, and will also provide input to combat models at the U.S. Army Concepts Analysis Agency (CAA). CAA is a Field Operating Agency functioning under the jurisdiction of the Director of the Army Staff. As part of its mission, CAA must evaluate the Army's operational capability to mobilize; deploy forces; and conduct unilateral, joint, and combined operations in various theaters of operations. CAA uses computer models, simulations, and other ADP tools and techniques to determine strategic mobility capabilities and requirements supporting several Defense Guidance objectives.

CAA's Transportation Model (TRANSMO) has been the primary tool providing data for deployment analyses. Over the past several years, the advent of CAA's Force Evaluation Model (FORCEM) as its primary theater campaign simulation, combined with requirements for such studies as the Ultra-Fast Sealift Study (UFSS) and the Army Strategic Mobility System Assessment (ASMSA), have clearly established the need for an improved deployment model.

In 1987, CAA conducted an internal study, the Transportation Evaluation Research Project (TERP), which examined the overall CAA strategic mobility process supporting a wide range of studies. TERP determined requirements for the CAA transportation analytical process and examined various models as possible alternatives to TRANSMO. None of the candidate models met all CAA's requirements, so a major TERP recommendation was that CAA pursue the acquisition of a new model to simulate both intertheater and intratheater transportation.

The GDAS project addresses only the intertheater transportation systems. Its objective is to provide a set of automated tools for detailed transportation analysis that will also furnish deployment data to support combat simulation models. CAA has published GDAS requirements in a report entitled "Strategic Transportation Analytical Requirements (STARS): Functional Description of a Global Deployment Analysis System." Ultimately, the intended larger system of which the GDAS is a part will simulate the mobilization of U.S. forces, deployment of forces and supplies across an intertheater network, and deployment of forces and supplies to the combat zone.

1.2 Phase II IV&V Summary

Potomac Systems Engineering, Inc. (PSE), is providing IV&V support to CAA during the GDAS development project. Phase II (implementation) was a 12-month effort in which the

model developers coded and integrated computer software in accordance with the GDAS System Design Specifications resulting from Phase I. PSE independently evaluated the prototype software and documentation provided to CAA by the model developers. Feedback from PSE to CAA on each item evaluated provided clear, objective statements of actual software capabilities and of deficiencies in content or function that could negatively impact the outcome of the GDAS development project. This report summarizes the IV&V work done by PSE during GDAS Phase II.

1.3 **Definitions**

Verification is the process of determining that a model represents its conceptual description and specifications. It is a continuing effort that reveals errors, omissions, and potential hazards early in the development process when errors are less expensive to correct. Verification involves evaluation and analysis to determine model consistency, completeness, and adequacy at each level of development.

Validation is the process of determining that a model accurately represents the intended system. During the development of a model, validation is best accomplished by establishing that the system achieves its specified functional and performance levels from the subsystem level to the fully integrated system in a reliable and efficient manner. This may include comparing results from separable modules or from the overall model with those from real-world entities, other verified and validated models, test and exercise data, or historical observations.

SECTION 2. DISCUSSION OF GDAS PHASE II IV&V ACTIVITIES

2.1 General

PSE is helping the government identify and resolve potential GDAS development problems as early as possible to minimize the cost impact on the GDAS development program and to rapidly assess the actual capabilities of delivered system prototypes. Experience has demonstrated that problems discovered late in a program, such as during the software integration and test phase, are very expensive to correct. Some potential problems can be averted through independent evaluation of the development specifications and by objective analysis of high-risk areas to help the government determine whether the solutions proposed by the software development contractor are adequate and cost-effective. Independent monitoring of the development process also helps to identify hardware and software inconsistencies as they occur, thus minimizing the time and resources expended in correcting such inconsistencies.

PSE's IV&V objectives during the GDAS implementation phase (Phase II) were to:

- o Develop a GDAS Phase II IV&V management plan
- o Exercise and evaluate GDAS prototypes
- o Review GDAS documentation
- o Support and participate in GDAS program reviews
- o Track GDAS developmental activities.

These objectives correspond to the tasks established in the Delivery Order for GDAS Phase II IV&V efforts. Activities and results supporting each Phase II objective are summarized in the following subsections.

2.2 Independent Verification and Validation Management Plan (IVVMP)

The GDAS IVVMP is a description and schedule of GDAS IV&V activities that is more detailed than the documents comprising the basic contract for the IV&V project. It reflects government schedules and priorities with greater accuracy than the contract documents because it was developed through discussions between CAA and PSE personnel who are directly involved in the GDAS project. The IVVMP is a "living" document that is updated periodically in response to changes in the GDAS development schedule or changes in CAA preferences for allocation of resources among tasks.

Information from the model developers about the steps to be performed in the GDAS development project and the scheduled dates for delivery of specific items such as the GDAS prototype software established much of the schedule for the IVVMP. Discussions with the GDAS Contracting Officer's Technical Representative (COTR) and other CAA

personnel involved in the development of the GDAS yielded preferred government priorities and guided the allocation of PSE resources to the various IV&V tasks.

The IVVMP developed for GDAS Phase II incorporated ongoing tasking and activities begun in Phase I, but was revised to reflect the specific tasks laid out for this phase of GDAS IV&V support. This IVVMP revision was delivered to CAA on 6 July 1990. No subsequent updates were required during Phase II because the IV&V management procedures laid out in the initial Phase II revision were appropriate for all subsequent IV&V activities. Work schedules and IV&V products, such as evaluations of GDAS development products, were coordinated through meetings, telephone discussions, and normal correspondence, including faxes and letters.

One example of the IV&V management procedures used in Phase II is the coordination of computer work sessions to evaluate GDAS software products delivered by the model developers. The COTR notifies PSE in advance of the upcoming software installation date and schedules GDAS computer time for IV&V work. Before the scheduled IV&V computer session, available information and/or documentation regarding the new software functionality is passed to PSE. This information is used to plan test cases for the evaluation of specific model functions, as discussed in section 2.3. Results are documented during the evaluation and are normally delivered to CAA on the day of the evaluation.

2.3 Independent Verification and Validation of GDAS Prototypes

The GDAS development schedule evolved from a traditional "waterfall" methodology to several iterations of prototype models, which progressively incorporate more of the features intended for the final GDAS system. IV&V procedures were established to help the government assess the effectiveness of the model developer's quality assurance (QA) and configuration management (CM) activities during model implementation by exercising and evaluating the capabilities of each prototype. This IV&V approach also provides the government accurate feedback on the performance of GDAS algorithms early in the model's development rather than waiting until the formal tests for model acceptance. PSE activity on this task began in Phase I and has continued through each successive prototype delivered by the model developers.

The exact IV&V procedures used at a particular stage in the evaluation of GDAS prototypes are determined in coordination with the COTR. This has been an iterative process requiring frequent interaction with CAA personnel. For the evaluation of a particular prototype model, it is necessary to:

- o Identify the features of the prototype that are newly added and those that were corrected from an earlier version to determine what tests should be performed

- o Prioritize the list of features and tests so that available IV&V resources can be allocated to the most significant tests
- o Schedule a series of model runs to assure the availability of personnel, equipment, and data for specific events
- o Exercise the model at each session to observe and assess the functions identified for examination in that session
- o Record the results of each session with comments on the functions exercised and any model deficiencies or discrepancies noted
- o Periodically update the planned run schedule to provide for retesting or additional tests based on the results of previous sessions
- o Perform literature searches and hold discussions with government experts to resolve questions or issues related to the desired performance of GDAS.

All of these procedures may be executed for particular prototype features, while subsets of these procedures are selected by the government for other prototype features to obtain the greatest possible benefits to the government within the agreed-upon level of effort under this contract. Figure 2-1 illustrates the flow of information regarding GDAS IV&V planning and results.

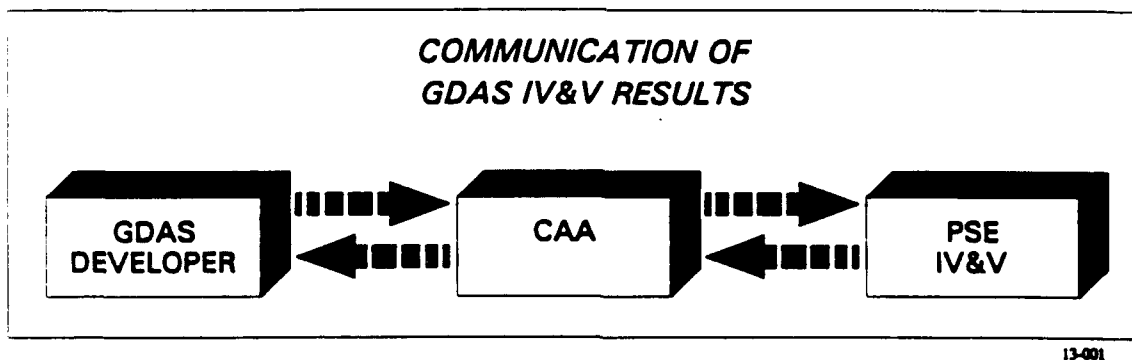


Figure 2-1. Communication of GDAS IV&V Results

GDAS IV&V tests are planned ahead of test cases such as those in appendix A. Each test case specifies the GDAS function to be evaluated, the input data tables and fields to be manipulated, and the output products to be observed (as raw output data, summary output tables, or graphics). Each test case also identifies the procedures and menu selections

needed to accomplish the desired evaluation. As much of this information as possible is developed from the available documentation before the scheduled IV&V computer session. On the day of the computer session, the planned test cases are briefly reviewed with the COTR before proceeding to the computer room. The COTR may provide guidance regarding the relative priority of the planned tests or suggest additional tests to evaluate model responses encountered by CAA personnel during initial runs of the newly installed GDAS capability.

During the IV&V computer session, the test steps and model responses are recorded as they occur on PSE-developed test observation forms, which are presented to the COTR at the conclusion of the computer session. For the most expedient application of IV&V results, completed IV&V test observation forms are normally provided directly to the COTR at the end of the computer session before the PSE IV&V team leaves the CAA offices. The COTR makes desired notations in a space on the form for this purpose, and forwards copies of the forms to the model developers if the IV&V results indicate a need for software modifications.

The GDAS Test Observation form shown in figure 2-2 was developed by PSE as a vehicle for effective communication among PSE IV&V analysts, CAA personnel, and the model developers on the results of running GDAS prototypes. At least one form is completed for each trial attempted in the run sessions to reflect successful completion or failure of the event. The forms are numbered sequentially and a copy of each completed form is maintained in a package controlled by the COTR for the GDAS development project. A block at the bottom of the form marked "For CAA Use" provides space to note plans for additional work related to each event. This form has been used by both CAA analysts and the model developer, and their suggestions on the format of the form have been incorporated.

Phase II IV&V tests of GDAS prototypes were performed in December 1990 and January 1991. These tests did not precisely follow the normal GDAS IV&V test procedures described above because the capabilities of the prototypes were not described in advance. For this reason, the IV&V computer sessions with the GDAS prototypes delivered during this time frame were used to explore the capabilities of the prototypes and experiment with the existing capabilities to determine their functionality. The IV&V computer sessions resulted in 27 GDAS Test Observations: 4 noted existing capabilities and 23 noted discrepancies in the GDAS program or data. The test observations included software problems in accessing menu selections and running the model as well as one function that, when selected, caused a complete exit from GDAS. Data problems included empty input tables, incomplete or inconsistent data entries, and identical data entries for lift assets or facilities that should have markedly different characteristics.

POTOMAC SYSTEMS ENGINEERING GDAS Test Observation			
Item number:	Analyst:		
Date:	Phone:		
Model Component:			
___ Input Data	___ Model	___ Results	___ Utility
Summary of Observation:			
Complete Description:			
<u>For CAA Use</u>			
Plan Followup?	Review Date:	Priority:	
Comment:			

PSE Form #84

Figure 2-2. GDAS Test Observation Form

Besides testing GDAS prototypes, the Phase II IV&V work under this task included support of CAA data acquisition and preparation efforts for anticipated GDAS testing. One effort involved delineation of GDAS airlift data requirements. Another involved interpretation of a notional logistics deployment scenario. In conjunction with a review of the GDAS representation of airlift, the GDAS COTR requested that PSE define and illustrate the air data that would be required to exercise the airlift simulation described by the GDAS developers. PSE participated in the GDAS airlift review, analyzed the applicable portions of the GDAS SDS and Data Dictionary, and developed a concise description of the airlift data required for GDAS and how it would be used in the simulation. This description was then used by the GDAS COTR in coordinating a request to Air Force sources for the required airlift data.

CAA also acquired from the U.S. Transportation Command (USTRANSCOM) a set of unclassified time-phased force deployment data (TPFDD) developed for a USTRANSCOM training plan. The data files and instructions provided by USTRANSCOM were incomplete, making it difficult to interpret the data for use in GDAS data tables. PSE analyzed the instructions and data files provided by USTRANSCOM to determine which data was appropriate for use in GDAS, then used an automated data base tool to extract the applicable data. Through this analysis, PSE was able to provide readable data tables containing data deciphered from the USTRANSCOM TPFDD and a projection of the additional data (and instructions) that would be necessary to use the USTRANSCOM deployment scenario in GDAS tests.

2.4 Review GDAS Documentation

PSE analyzed documents generated by the GDAS model developers to assess whether each document was technically correct and consistent with other related GDAS documents. Each document was evaluated for its compliance with the format and content specified by the government. PSE coordinated with the COTR to obtain the following documents needed to perform the document reviews:

- o Document to be reviewed
- o Applicable development contract provisions (e.g., SOW)
- o Applicable DoD standards and associated documentation
- o Review criteria unique to the document
- o Previous review reports
- o Correspondence related to the document's contents.

Deviations, errors, and/or ambiguities in format and content were reported to the government with recommended corrective actions. The effectiveness of PSE's thorough, constructive IV&V reviews was formally acknowledged by the GDAS COTR and by the model developers (Stanley Associates) during the final GDAS System Design Briefing.

The following GDAS documents were analyzed by PSE during IV&V Phase II:

- o GDAS System Design Specification (Final, July 1990)
- o Related letters, papers, and memoranda
- o GDAS Functional Description
- o GDAS Data Dictionaries
- o GDAS Source Code (as of 3 May 1990).

Due to an overlap between the beginning of GDAS IV&V Phase II and the completion of GDAS development Phase I (the design phase), PSE analyzed and provided critical feedback on the Final GDAS System Design Specification (SDS) during IV&V Phase II. The original GDAS SDS was analyzed by PSE in March 1991. Because of feedback from PSE and from CAA personnel who also reviewed the original SDS, the GDAS developers published a revised SDS (Version 1.1). Analysis of SDS Version 1.1 by PSE and CAA personnel again resulted in revision of the SDS by the GDAS developers to produce the final SDS version that was delivered at a GDAS System Design Review in July 1990.

PSE's analysis of the final GDAS SDS included a thorough comparison of the SDS with the GDAS Functional Description (FD) prepared by CAA. The GDAS COTR provided, as a supplement to the GDAS FD, a file of letters, papers, and memoranda related to the GDAS design effort. The contents of this file reflected agreements and open issues between CAA and the model developers regarding GDAS design features that supplanted or extended the requirements of the GDAS FD. These supplemental documents were used as references during the final SDS analysis to establish a comprehensive perspective for assessment of the SDS.

PSE's assessment of the final GDAS SDS included general observations regarding SDS compliance with the applicable requirements and standards specified by CAA and a list of observations regarding significant SDS deficiencies. The observations regarding SDS deficiencies were keyed to specific paragraphs of the SDS itself and included discussions of the analysis leading PSE to the assessment of a deficiency in each case. Finally, PSE's review of the final GDAS SDS included extracts from the GDAS FD, highlighting requirements that were not satisfied or were only partially satisfied by the final GDAS SDS.

A GDAS source code printout provided by the GDAS COTR was reviewed by PSE and used with the GDAS Data Dictionary to clarify the design of several GDAS features that were not adequately described in the GDAS SDS. The source code itself was not evaluated in the IV&V context as a deliverable from the model developers. Documentation of the available source code was not consistently helpful but did clarify a number of points during the IV&V review of the GDAS SDS.

Throughout the development of the GDAS PSE has provided CAA a concise IV&V assessment of each document reviewed. Each assessment was written in the context of previous and ongoing GDAS development activities. The IV&V comments on document

deficiencies spelled out the nature of the problem, why it was considered a problem, and the possible effect of the problem on the GDAS development project. When appropriate, the IV&V comments also recommended an approach to resolving the problem. The result of this approach was that the model developer used many of PSE's IV&V comments as the basis for improvements in the GDAS design and in their associated documents.

2.5 Support and Participate in GDAS Program Reviews

PSE supported the GDAS development project by participating in all GDAS system reviews. During formal reviews, PSE analysts abstained from discussion as instructed by the COTR, and provided written IV&V feedback on significant issues that arose during the review.

Within five working days after participating in each system review, PSE provided feedback to CAA on discrepancies, shortfalls, or issues resulting from the review that could impact the quality of the GDAS model development. Each issue that PSE raised included an explanation of why it was considered a significant issue and the possible impact it could have on the GDAS development schedule or the utility of the final GDAS analysis tool.

Only one CAA Agency Review Board (ARB) was convened for a GDAS development review during GDAS IV&V Phase II. On 12 July 1990, the model developer briefed the final GDAS System Design Specification. The PSE feedback on this review highlighted four issues: the GDAS hardware and software architecture, complexity of the transportation network, planned user training schedule, and interpretation of DoD software development standards.

The GDAS COTR informally reviewed the GDAS representation of airlift at the model developer's offices in October 1990. PSE was invited to participate in this review for two reasons:

- o To assess the representation of airlift being implemented in GDAS
- o To gather background detail for a capsulized description of the input data required for the GDAS airlift simulation.

PSE's participation in this informal GDAS development review was more extensive than in the formal reviews previously conducted at CAA. We supported the COTR in a two-way question-and-answer format in which the COTR initiated the discussion topics, the model developers presented the current design and status, and PSE both solicited additional detail and provided additional information regarding the real-world airlift system that the GDAS developers were modeling. PSE feedback on this model review included the usual IV&V assessment of information provided by the developers within five work days after the review.

In addition to the IV&V assessment, PSE also matched detailed information gained from the informal GDAS airlift review in combination with the GDAS Data Dictionary to

develop a clear, concise description of GDAS data inputs regarding airlift. We included a list of the GDAS data base tables containing data regarding airlift and described how the data would be used in the GDAS airlift simulation. The GDAS COTR used PSE's description of the GDAS representation of airlift to coordinate with Air Force data sources in requests for GDAS airlift data.

2.6 Track GDAS Developmental Activities

The primary reason for tracking GDAS developmental activities was to facilitate responsive planning of IV&V activities. PSE also helped the GDAS COTR maintain focus on key action items and issues that could adversely affect the GDAS development project. The method PSE used to track GDAS development activities was different from the method we originally proposed but was more completely integrated with other aspects of the IV&V process.

The major differences between the method PSE proposed and the method we used for the GDAS action tracking task are in the degree of automation and the amount of analysis required. PSE initially proposed an automated action tracking data base linked to the GDAS requirements data base. Using this method, each item designated for entry into the action tracking data base (e.g., meeting minutes) would be analyzed to identify specific action items. Key words or numeric codes showing relationships to GDAS requirements would be assigned to each action item. The coded action items would then be entered into an automated data base and customized report formats would be established to retrieve items periodically or on request. A standard monthly report could show all open action items and action items that were closed during the previous month. Similarly, the GDAS COTR could request a report showing only current (or prior) action items related to specific requirements (or key words). A time lapse between the beginning of the GDAS development project (May 1989) and the beginning of GDAS IV&V work (September 1989), combined with a desire for fusion of GDAS requirements and related system design issues, led to a CAA decision to seek an alternate method for GDAS action tracking by the PSE IV&V team.

The PSE IV&V team leader and the CAA COTR for GDAS development held meetings and telephone discussions once a week on the average (sometimes daily) to review current GDAS action items and issues. PSE provided written reviews or working papers on key factors identified in these discussions. The action tracking process helped PSE prepare IV&V products focused on current GDAS design issues while taking account of prior GDAS development activities.

One example of the IV&V support provided by PSE as a result of the action tracking process during Phase II was the IV&V input to CAA's mid-phase change in the GDAS data base management system (DBMS). At the beginning of Phase II, the GDAS data base development plan was to establish the GDAS data base capability using the Paradox DBMS system and to port the data base to INGRES during the final stages of GDAS development

and integration. As the implementation of GDAS software progressed, the capabilities of Paradox and INGRES were reassessed relative to GDAS requirements. PSE became involved in this discussion during its early stages through the action tracking process. Participating in the Paradox/INGRES discussion from its beginning, the PSE IV&V team was able to provide relevant information for consideration in CAA's final decision.

PSE tracked GDAS developmental activities manually through a system of files and calendars maintained mostly at PSE. Updates were accomplished through a flow of telephone calls, meetings, letters, and memoranda between PSE and the CAA COTR for the GDAS development project. PSE feedback on items requiring attention was provided to the COTR in telephone calls, meetings, letters containing issues from program reviews, PSE reviews of GDAS documentation, and GDAS test observations resulting from prototype model operations.

SECTION 3. CONCLUSION

PSE's GDAS IV&V Phase II support during the implementation of the GDAS model has contributed to the model design, CAA's initial data collection efforts, and the overall quality of the GDAS software suite. As the GDAS IV&V agent, PSE continually provided thorough, objective, and constructive evaluations of the GDAS design features, documentation, and model prototypes delivered to CAA by the model developers. PSE's participation in GDAS system reviews resulted in concise and timely analytical feedback to CAA on issues raised during each review that could adversely impact the GDAS development project. PSE also contributed IV&V expertise to other CAA efforts such as delineation of GDAS data requirements to exercise critical model features and analysis of data obtained from other sources to determine its applicability to the GDAS database.

PSE activities related to the operation and evaluation of GDAS model prototypes continued throughout the GDAS Phase II IV&V contract period. One important aspect of software evaluation is the preliminary planning and coordination of tests that will be performed. The preliminary steps include reviewing and analyzing available documentation, analyzing previous test results, designing and preparing test data sets, and scripting test procedures. PSE's procedures for IV&V test planning and coordination have produced efficient and accurate assessments of the software delivered by the GDAS developers. In addition to the software tests performed during the GDAS IV&V Phase II contract period, some preliminary planning has been done for tests of software that is yet to be delivered by the GDAS developers. The test cases themselves are not a required deliverable of GDAS IV&V Phase II but are included in appendix A for informational purposes. Some of the test cases planned for upcoming GDAS prototypes are incomplete because the features, functionality, and operating procedures for the prototypes are not clearly known at this time. All of these test cases must be checked against the final data dictionary and operational procedures of the GDAS version with which they are used.

A number of additional steps must be taken to maintain and build on the contributions that the PSE IV&V team has made to the GDAS development project. According to the current GDAS development schedule, two GDAS prototypes are planned for delivery to CAA before the final GDAS system is delivered. Each prototype should be evaluated in the same manner as the previous prototypes. Each should be checked to determine whether it includes corrections to problems discovered in earlier versions, then to determine the functionality of added features. The IV&V test cases in appendix A should be completed and added to for evaluation of the GDAS prototypes and for acceptance testing of the final GDAS system. Data must be collected and prepared for these tests and for eventual application of the model in deployment studies. Finally, before the GDAS system enters the "operations and maintenance" phase of its life cycle, a pilot study should be conducted with a scenario representative of the studies in which the model is expected to be used.

APPENDIX A
POTENTIAL GDAS IV&V TEST CASES

APPENDIX A

POTENTIAL GDAS IV&V TEST CASES

The documents in appendix A represent work in progress on potential test cases for GDAS prototypes and for the final GDAS model. This work was accomplished as a foundation for preparing an IV&V Test Plan, which would include additional details of data and procedures based on documents not yet delivered by the GDAS developers. The anticipated documentation includes the final GDAS Data Dictionary, a User's Manual, and Detailed Algorithm Specifications. It is expected that these documents will clarify the relationships between the GDAS simulation inputs, system parameters, and output data that is not available in the System Design Specification (SDS) or in the available version of the GDAS Data Dictionary (dated 19 December 1990). The potential test cases included in this appendix were developed during GDAS Phase II IV&V when schedule delays by the model developer created slack time in the IV&V schedule.

Three lists of candidate tests were prepared at different times and from different sources. The lists were developed from the GDAS Functional Description (FD) and SDS, and from correspondence and meeting minutes regarding GDAS design features. It is anticipated that as the test cases are updated from documentation of pending GDAS prototypes and of the final GDAS implementation, the additional detail available will spawn related tests. As test cases were prepared, the analysis of GDAS requirements associated with each candidate test revealed that some items seemed to duplicate items on another list. Related items on the candidate test lists will be compared with the final GDAS documentation to determine whether nuances of function not expressed in the SDS or the available data dictionary will indicate that the candidate test issues are not identical.

For convenience in developing the tests, each test case is assigned a number corresponding to its position on a list of candidate tests. The number assigned to each test case has two parts, the first part indicating the list it came from and the second part indicating its position in the cumulative sequence of all cases in the three lists. Test case 2-27 is from the second list of candidate tests, and is the twenty-seventh candidate test in the cumulative list of candidate tests. As the GDAS development process draws to a close, the completed test cases will be recategorized by GDAS subsystem and function, and by test priority.

Finally, the requirement statements have been modified from their initial contents in most of these test cases. The GDAS FD was originally the primary source for requirements and evaluation criteria in these test cases. The GDAS SDS was a secondary source, to be used for test requirements not based in the GDAS FD. Due to recent developments, CAA asked that PSE base all GDAS IV&V test cases on requirements expressed in the GDAS SDS. This revision has been performed to the extent possible, as indicated in the test cases.

GDAS IV&V TEST CASE DESCRIPTION

IV&V ISSUE: A brief statement or phrase indicating the nature of the test to be performed.

GDAS SUBSYSTEM: Name of the GDAS subsystem to be evaluated in this test (data base, presentation graphics, transportation graphics, movement requirement generation, or transportation model).

REQUIREMENT SOURCE: Name or description of the source for the stated requirement upon which the test is based.

REQUIREMENT STATEMENT: The GDAS system requirement or design specification describing the capability to be tested. Test requirements may also be generated from the contract Statement of Work, related correspondence, or other sources describing intended GDAS capabilities (to be coordinated with the GDAS COTR).

TEST OBJECTIVE: A statement of what is to be determined by the test to be performed.

TEST PROCEDURES: A general description of steps to be performed for the test. This may include test setup, special input data requirements, and requirements for hardware or software that is not part of the GDAS architecture. Additional information sources (data sources, instruction manuals) may be included by reference.

DATA COLLECTION REQUIREMENTS: A description or list of data that will provide a basis for assessment of test results. This data will normally be GDAS system output or observations of system performance collected during the test.

EVALUATION CRITERIA: A description or list of criteria against which the test results will be assessed. Criteria for these tests will emphasize the concerns of greatest interest for the current phase of GDAS development.

GDAS IV&V TEST CASE # 1-1

IV&V ISSUE: Identify anomalies in cargo travel itineraries.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS COTR.

REQUIREMENT STATEMENT: Be able to trace cargo delay to lack of availability of transportation assets or to port congestion. Relate such results to the trouble report.

TEST OBJECTIVE: Confirm scheduler problems identified in previous runs and attempt to identify the cause. Two unusual cases of cargo lateness were reported:

- o Late cargo was loaded on a ship that sat in port for 10 days while similar ship/cargo combinations sailed to destination.
- o Cargo destined for the Persian Gulf was loaded on a ship that made several round trips between CONUS and NATO before going to Persian Gulf.

TEST PROCEDURES: Run queries on GDAS output data to:

- o Find the cargo delivered longest after its RDD
- o Obtain the itinerary of the ship(s) or aircraft that transported the cargo
- o Determine whether the cargo was late loading or delayed en-route
- o Identify delays contributing to the cargo's lateness.

NOTE: The GDAS rejection report (trouble report?) only identifies reason(s) for cargo not being scheduled within a user-specified time window of its TLD.

DATA COLLECTION REQUIREMENTS: Data to be collected in this test includes the results of queries run during the test and observations regarding cargo delays indicated by the results. Any entries in the trouble report regarding the identified cargo will be extracted and the user-specified time window will be recorded.

EVALUATION CRITERIA: Two criteria will be used in this test:

- o It should be possible to identify the reasons for cargo lateness using standard GDAS queries.
- o The trouble report should list the reasons for not loading cargo within the user-specified window.

GDAS IV&V TEST CASE # 1-2

IV&V ISSUE: Aerial refueling on airlift missions.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.1.

REQUIREMENT STATEMENT: In GDAS, the transportation network is basically defined by nodes and links. Typical nodes may represent origins, destinations, airports, seaports, truck or rail terminals, airdrop nodes, air refueling points, etc.

TEST OBJECTIVE: Verify aerial refueling capability for GDAS airlift missions. It should be possible to reduce transit time for airlifted cargo by substituting aerial refueling for intermediate landings.

TEST PROCEDURES: Choose a GDAS run in which airlift missions stop for fuel only (e.g., CONUS to Persian Gulf). Create an aerial refueling node bisecting a long link such as the transatlantic leg. Run the model again and check the output for aircraft visiting the aerial refueling node.

DATA COLLECTION REQUIREMENTS: Identify the cargos on aircraft using the aerial refueling node and their transit time from POE to POD. Compare transit times for the same cargos (if airlifted) in the base run.

NOTE: Check whether this procedure would be simplified by using a "special mission."

EVALUATION CRITERIA: Aerial refueling nodes should be used in lieu of landing for fuel only. Airlift transit times (POE - POD) should decrease when aerial refueling is used.

GDAS IV&V TEST CASE # 1-3

IV&V ISSUE: Effect of canal closure on ship routing.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.1.

REQUIREMENT STATEMENT: In GDAS, the scheduling decisions and simulations are performed each day within an iterative process that is patterned after real-world transportation schedulers. Major steps in the daily process include replanning and/or re-scheduling to take into account "surprise" time variations (e.g., canal closures) not foreseen during planning and scheduling.

TEST OBJECTIVE: Confirm that GDAS will perform an appropriate ship diversion if its destination port (or canal passage) closes while the ship is en-route.

TEST PROCEDURES: Choose a run where ships use a canal (e.g., Suez or Panama). Enter "timevarying" data to close a selected canal one day before ships are scheduled to transit the canal. Rerun the scenario and compare the itineraries of ships that used the canal in the base run.

DATA COLLECTION REQUIREMENTS: Identify and obtain itineraries of ships transiting canals in the base run. Obtain itineraries of the same ships in the excursion.

EVALUATION CRITERIA: Ships should not transit the canal during the closed period. Itineraries of identified ships should be the same in the excursion as in the base run until the stop just before using the canal (unless mission is planned after the canal closes). Itinerary in the excursion should provide a feasible route avoiding the canal.

GDAS IV&V TEST CASE # 1-4

IV&V ISSUE: Effect of airport closure on airlift routing.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.9.

REQUIREMENT STATEMENT: To determine the trade-off between payloads and refueling, GDAS uses a forward-reaching dynamic programming method as illustrated in figure 5-8. The objective is to achieve the maximum average tons per day throughput and to identify standard routes depending on the aircraft type.

TEST OBJECTIVE: Confirm that GDAS will perform feasible lift vehicle diversion if a port is closed while a mission is en-route. The test procedure is described for aircraft and airports; a similar procedure will be used for ships and seaports.

TEST PROCEDURES: Choose a busy airport from an existing run. Enter "timevarying" data to close the selected airport during a period of high activity. Rerun the scenario and compare the itineraries of aircraft that used the airport in the base run.

DATA COLLECTION REQUIREMENTS: Identify and obtain itineraries of aircraft using the selected airport in the base run. Obtain itineraries of the same aircraft in the excursion.

EVALUATION CRITERIA: Aircraft should not use the airport during the closed period. Itineraries of identified aircraft should be the same in the excursion as in the base run until the stop just before the selected airport (unless mission is planned after the airport closes). Itinerary in the excursion should provide a feasible route avoiding the closed airport. Aircraft and cargos at the airport when it closes should not be processed during the closed period.

GDAS IV&V TEST CASE # 1-5

IV&V ISSUE: Dynamic selection of convoy assembly locations.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.10.

REQUIREMENT STATEMENT: If a movement requirement has a destination in a theater for which convoying operations have begun, and if a given ship must be convoyed based on the convoy speed criterion, then a separate calculation is performed to identify the nearest convoy assembly node and disassembly node based on great circle distances.

TEST OBJECTIVE: Confirm that GDAS selects the nearest convoy assembly node to the POE for ships going to a particular theater. Also determine whether the proximity of a disassembly node to the POD is a planning factor. (NOTE: Fields in table CONVOY imply a single assembly node and a single disassembly node for each convoy route. Which determines route selection?)

TEST PROCEDURES: Select or create a NATO deployment scenario with at least two active convoy routes from CONUS to NATO. Identify ships that use the convoy routes and determine the distance of their last POE stop from each available convoy assembly point. Also determine distance to each ship's first POD stop from each available convoy disassembly point.

DATA COLLECTION REQUIREMENTS: Get itineraries of ships using convoy routes and locations of available convoy assembly/disassembly nodes. Should use the same formula used in GDAS to compute distances. (The Transportation Graphics subsystem may be useful in this test.)

EVALUATION CRITERIA: Ships using convoy routes should proceed from their last CONUS POE stop to the nearest convoy assembly node.

GDAS IV&V TEST CASE # 1-6

IV&V ISSUE: Cargo marry-up/assembly in a theater.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.2.

REQUIREMENT STATEMENT: The GDAS model design explicitly accounts for the coordination of multiple, interdependent movements which are characteristic of DoD intermodal transportation, including cargos which are related by precedence sequencing (e.g., a multimodal staged movement in which an airlift leg depends on a prior sealift leg), or assembly dependency (e.g., multiple air/sea or POMCUS movements which must marry up at a marshalling or staging location before moving forward), or balanced force links (e.g., CS/CSS/supply movements which are assigned to support a combat unit).

TEST OBJECTIVE: Confirm that GDAS can represent deployment situations in which requirements must be matched after POD arrival (e.g., people and equipment) before proceeding to final destination.

TEST PROCEDURES: Enter or check data in tables REQUIRE, REQMATCH, REQNODE, and THTRREQ as necessary to identify the movement requirements that must be assembled in theater. Run the model and check cargo itineraries to establish that all requirements were at the assembly node for the prescribed time period before any moved past the assembly node.

DATA COLLECTION REQUIREMENTS: Requirements and theater data showing which requirements must be matched and where as well as the time required for marry-up. Also need cargo itineraries.

EVALUATION CRITERIA: All matched requirements should arrive at the assembly node. The specified minimum time period should pass before the last matched cargo arrives before any of the matched cargo departs the assembly node.

GDAS IV&V TEST CASE # 1-7

IV&V ISSUE: Discrete-event attrition of lift vehicles and cargo.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.14.

REQUIREMENT STATEMENT: Attrition submodels at the nodes are expressed as discrete probabilities. The discrete probability is applied to vehicles upon port departure after any cargo has been loaded or unloaded.

TEST OBJECTIVE: Confirm that the optional discrete-event attrition (upon port departure) in GDAS operates as planned. The cargo actually on board an attrited vehicle should also be attrited.

TEST PROCEDURES: Query the output from one GDAS run where discrete-event attrition is enabled. The following steps should provide the necessary information:

- o Identify all attrited vehicles
- o Identify all cargo loaded on each vehicle at time of loss
- o Confirm that the identified cargo is attrited before reaching POD
- o Confirm that no other cargo is attrited before reaching POD.

DATA COLLECTION REQUIREMENTS: List of attrited vehicles and attrited cargo. Itineraries for attrited vehicles, including cargo loaded and unloaded at each stop.

EVALUATION CRITERIA: Three criteria will be used in this test:

- o The cargo loaded on the attrited lift vehicles at the time of attrition should not arrive at POD.
- o The quantity of cargo attrited should match the quantity of cargo loaded on the lift vessel at the time of its loss.
- o No other cargo should be removed from the simulation unless it is attrited at a port.

GDAS IV&V TEST CASE # 1-8

IV&V ISSUE: Exclusion of fleets from specific theaters.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Facilities can be constrained as to whether refueling is permitted and which types of vehicles can be handled (e.g., C-17s may be unable to land at certain airports, or NATO fleets may be excluded from Korean seaports, or military aircraft only are permitted at airdrop facilities which have reduced unload rates).

TEST OBJECTIVE: Confirm that GDAS has the capability to dedicate a "fleet" of ships to one theater and to exclude that fleet from another theater.

TEST PROCEDURES: Identify (from an existing run) a class of ships that is used in missions to several theaters. Designate this class of ships as a fleet in tables SHIP and SHIPFLT. Use table EXCLUDE to exclude this fleet from a theater (or node/facility) that was used by the designated class of ships in the base run. Run the excursion and check whether ships in the designated fleet avoid the excluded theater (or node/facility).

DATA COLLECTION REQUIREMENTS: Itineraries of ships in the designated fleet.

EVALUATION CRITERIA: Ships excluded from a theater (or node/facility) should not be used to transport cargo to or from that facility. (Question: What happens if you exclude a fleet from CONUS?)

GDAS IV&V TEST CASE # 1-9

IV&V ISSUE: Dynamic selection of cargo lift mode.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.1.

REQUIREMENT STATEMENT: For scheduling, the model uses mathematical optimization algorithms and heuristic scheduling techniques to make decisions such as mode selection between airlift, sealift, or other transportation modes.

TEST OBJECTIVE: Confirm that the GDAS scheduler will automatically select an appropriate transportation mode when a movement requirement does not specify a transportation mode.

TEST PROCEDURES: Select or create a scenario with numerous air transportable cargos (e.g., bulk) that do not have a designated transport mode but are destined to the same theater. Identify a group of cargos for the test and divide them in half. Set dates for one half so airlift is the only possible mode to meet the RDD and set dates for the other half to allow timely delivery by sealift. (Available dates in table REQUIRE are RLD, EDD, and RDD.)

NOTE: Selected cargos should not be linked to any others. It may be best to use resupply cargos.

DATA COLLECTION REQUIREMENTS: Obtain travel mode and load/unload dates for selected requirements. Use ad hoc queries to research anomalies. May need to determine cargo priority or delivery benefit relative to similar cargo.

EVALUATION CRITERIA: Cargo with short movement windows should primarily use airlift mode. Cargos with long movement windows should primarily use sealift mode.

GDAS IV&V TEST CASE # 1-10

IV&V ISSUE: Dynamic selection of POE and POD.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.6.

REQUIREMENT STATEMENT: The planning process routes a movement requirement from an assigned starting node (either the initial origin or an intermediate origin which represents the end node of a previously scheduled cargo) through the transportation network to its final destination, possibly through several modes of transport. The planning methodology uses a node-oriented shortest path type algorithm as an outer framework, but actually uses forward-reaching dynamic programming to evaluate alternate states at each node since multiple penalty criteria must be evaluated as well as linking dependencies to other scheduled cargo.

TEST OBJECTIVE: Confirm that for a given movement requirement GDAS will select the nearest POE to cargo origin and the nearest POD to cargo destination.

TEST PROCEDURES: Select movement requirements destined to each theater played in a scenario. Find each POE and POD used to move the selected requirements. Check an area around each cargo origin to determine whether any POE is closer and check an area around each cargo destination whether any POD is closer than the ones used in the simulation. If so, check ship availability, total cargo throughput, and cargo priorities at closest ports to determine why they were not used.

NOTE: Transportation graphics may help with this test if available.

DATA COLLECTION REQUIREMENTS: The following data will be needed:

- o Selected cargo requirements by theater.
- o Origin and destination for each cargo.
- o Distances from origin to POEs and from PODs to destination.

EVALUATION CRITERIA: Cargo should transit the POE nearest to its origin and the POD nearest to its destination.

GDAS IV&V TEST CASE # 1-11

IV&V ISSUE: Intermediate staging operations.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.2.

REQUIREMENT STATEMENT: The GDAS model design explicitly accounts for the coordination of multiple, interdependent movements which are characteristic of DoD intermodal transportation, including cargos which are related by precedence sequencing (e.g., a multimodal staged movement in which an airlift leg depends on a prior sealift leg), or assembly dependency (e.g., multiple air/sea or POMCUS movements which must marry up at a marshalling or staging location before moving forward), or balanced force links (e.g., CS/CSS/supply movements which are assigned to support a combat unit).

TEST OBJECTIVE: Confirm that GDAS has the capability to use intermediate staging locations where cargo changes vehicles or modes of transport.

TEST PROCEDURES: Select or create at least two movement requirements with staging. Use tables REQNODE and STAGE to enter EAD, LAD, and delay days at the stage node and other pertinent staging information. Run model and check itineraries of the selected requirements for compliance with staging inputs.

DATA COLLECTION REQUIREMENTS: Itineraries for selected requirements.

EVALUATION CRITERIA: GDAS scheduler should stage the movement requirements according to the input times.

GDAS IV&V TEST CASE # 1-12

IV&V ISSUE: Representation of mechanical vehicle failure.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS COTR.

REQUIREMENT STATEMENT: COULD NOT FIND THIS REQUIREMENT IN FD OR SDS.

TEST OBJECTIVE: Confirm that GDAS transportation vehicles experience delays due to mechanical failures requiring en-route maintenance or return to port.

TEST PROCEDURES: To be determined. It appears that only attrition or combat damage can affect a lift vehicle during a simulation. (The definition of the "Do Attrition?" field in table PARAM indicates it is used for attrition or breakdown, but no other reference to breakdown could be found.)

DATA COLLECTION REQUIREMENTS: To be determined.

EVALUATION CRITERIA: To be determined.

GDAS IV&V TEST CASE # 1-13

IV&V ISSUE: Balanced forces linking capability.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.18.

REQUIREMENT STATEMENT: The balanced forces concept occurs in GDAS to ensure that combat support units follow associated combat units in a timely fashion.

TEST OBJECTIVE: Confirm that GDAS has the capability to schedule cargos according to input balanced force links.

TEST PROCEDURES: Select or create a set of related combat and combat support unit requirements. Enter the predecessor/successor requirement IDs and desired lag time in table REQLAG. Run the model and check itineraries of the selected requirements for compliance with the input links.

DATA COLLECTION REQUIREMENTS: Identify related combat and combat support requirements. Obtain movement itineraries for the selected requirements.

EVALUATION CRITERIA: Two criteria will be used in this test:

- o Predecessor cargos should arrive before successor cargos.
- o Successor cargos should lag by the input lag days.

GDAS IV&V TEST CASE # 1-14

IV&V ISSUE: Capability for CRD or SRD to override RDD.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The analyst will have the option of altering scheduling priorities by modifying the penalties assigned to the control variables associated with each goal, or by modifying the simulation RDD.

TEST OBJECTIVE: To be determined. CRD stands for CINC's RDD (table UNIT), defined as the CINC's original required delivery date relative to M-day. The RDD in table REQUIRE apparently drives the simulation, but the connection between the two dates is not defined. Need a definition for SRD (could be Simulation RDD, ref SDS page 2-4).

TEST PROCEDURES: To be determined. The SDS does not describe how the CRD or SRD can be substituted for the Requirement RDD during a run. The GDAS User's Manual, when published, should provide the necessary procedures. If this test must be performed before the User's Manual is available, the procedure should be requested from the model developers.

DATA COLLECTION REQUIREMENTS: To be determined. The basic set of data required for this test will include the Requirement RDD and the CINC's RDD for a set of data as well as output regarding the actual cargo delivery dates.

EVALUATION CRITERIA: Designated cargo requirements should be delivered on or before the CINC's RDD. Closure and lateness calculations should be relative to the CINC's RDD.

GDAS IV&V TEST CASE # 1-15

IV&V ISSUE: Analyst control of cargo movement priorities.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.15.

REQUIREMENT STATEMENT: The major criteria for sorting cargos is the Target Lift Date (TLD) calculated during the planning. Among all cargos with the same TLD, the analyst can set the movement priority to ensure the most important movements have the best chance of obtaining transportation resources.

TEST OBJECTIVE: Confirm that GDAS schedules cargos according to input movement priority.

TEST PROCEDURES: Identify or create a set of movement requirements (at least three) going from the same origin to the same destination with the same RDD. Assign a different priority order to each requirement (1 means first priority). Run the model and check cargo itineraries to determine whether the cargos were moved according to the specified priority order.

DATA COLLECTION REQUIREMENTS: Need cargo itineraries for selected requirements (including name of lift vehicle). May need cruise speeds of lift vehicles used to transport the cargos.

EVALUATION CRITERIA: Cargos with higher priority should be delivered before cargos with lower priority if their RDD is the same.

GDAS IV&V TEST CASE # 1-16

IV&V ISSUE: Capability to expand GDAS geographic data.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: GDAS will simulate an unlimited number of theaters or contingency areas.

TEST OBJECTIVE: Confirm that Stanley Associates' representation of the globe by 700 nodes can be expanded by analysts to add new port facilities.

TEST PROCEDURES: Add air and sea ports to an existing scenario. Add one APOD and one SPOD to a theater that is used in the scenario. Also add one APOE and one SPOE to a CONUS area from which requirements move to that theater. (Give the new ports capabilities similar to the existing ports.) Link the new ports to existing intermediate nodes in the area. Run the model and check that the new ports are used.

ALTERNATE PROCEDURE: Add a set of cargo requirements to an existing scenario for delivery in an area not used in prior runs (e.g., Antarctica). Add nodes and links to expand the transportation network in that area. This procedure would require more extensive data base modification than the previous procedure.

DATA COLLECTION REQUIREMENTS: Review itineraries of requirements destined to a specific theater in a prior run. Identify ports and routes used in the prior run so new ports can be established in the immediate proximity. Check itineraries of requirements moved to the same theater in the excursion.

EVALUATION CRITERIA: The added ports should be used to move cargo to the selected theater.

GDAS IV&V TEST CASE # 1-17

IV&V ISSUE: Compile graphic output from different runs.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: In addition to the capability of producing standard reports, the model will be supported by an independent DBMS which will allow the analyst to quickly perform ad hoc queries concerning particular model runs.

TEST OBJECTIVE: Confirm that the Paradox DBMS can merge data from several GDAS runs into a single table or graph.

TEST PROCEDURES: Select or create a set of at least three related GDAS scenarios that have notable differences in a selected MOE between the runs. Ensure that each run's files are in a separate directory. Use the GDAS menu system to extract data on the selected MOE from each run and combine the data into a single table. Graph the results. Compare the combined table and graph with output from the individual runs.

DATA COLLECTION REQUIREMENTS: Data on the selected MOE from each run. A combined table showing all of the data from the individual runs. Graphs of the selected MOE from each run and from the combined table.

EVALUATION CRITERIA: GDAS should allow the analyst to combine the data from separate runs. The data in the combined table should be the same as data extracted from the separate runs.

GDAS IV&V TEST CASE # 1-18

IV&V ISSUE: Propagation of packaged cargo deliveries to UIC closure dates.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.17.

REQUIREMENT STATEMENT: The analyst can specify ranges such as 5-day accumulated packages based on RDD. **NOTE:** The original UIC level movement requirements are retained to perform unpackaging of the final schedule for input to the combat simulation models.

TEST OBJECTIVE: Confirm that when cargos are packaged for transport the visibility of the disaggregated movement requirement is retained in the final unit closure date.

TEST PROCEDURES: Select an existing scenario that does not use cargo packaging (RLD packaging range and RDD packaging range are set in table PARAM). Identify a set of requirements where packaging is feasible based on RLD and POEs near cargo origin. (Transportation graphics may be helpful for this step.) Set ranges in table PARAM for packaging based on RLD. Identify another set of requirements where packaging is feasible based on RDD and PODs near cargo destination. Set ranges in table PARAM for packaging based on RDD. Run the model and calculate unit (TPSN) closure based on all requirements to compare with the closure date reported by the model. Also check that movement requirements were packaged as intended.

NOTE: GDAS design specification (para 5.17) implies that any subset of movement requirements (e.g., Air Force resupply) can be selected for packaging. The data dictionary does not seem to offer this capability.

DATA COLLECTION REQUIREMENTS: Movement requirements data including origin, RLD, destination, and RDD. Closure required percentages (table REQTYPE) to calculate closure dates. Cargo Itineraries (including name of lift vehicle) to confirm cargo was packaged.

EVALUATION CRITERIA: Cargo should be packaged as indicated by input parameters. Closure dates computed in post-run queries (including packaged cargo) should match closure dates computed by the model (table REQUIRE).

GDAS IV&V TEST CASE # 1-19

IV&V ISSUE: Balancing cargo lateness against lift asset utilization.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.7.

REQUIREMENT STATEMENT: A variety of penalty factors are used to evaluate alternative cargo/ship assignments for scheduling. These penalty factors define tradeoffs between multiple objective function criteria such as cargo timeliness and ship utilization.

TEST OBJECTIVE: Use relatively higher values of the input "new ship penalty" to cause greater utilization of ship capacity.

TEST PROCEDURES: Compare average percent fill per ship in three GDAS runs where the only change between runs is the value of the new ship penalty. Indeterminate or unexplainable results may require more model runs.

NOTE: This test can also confirm the capability to combine data from different runs in a table or graph.

DATA COLLECTION REQUIREMENTS: Need percent fill by ship type for each run (table RPTSTYPE).

EVALUATION CRITERIA: Changes in the average percent fill by ship type should be inversely proportional to changes in the "new ship penalty."

GDAS IV&V TEST CASE # 1-20

IV&V ISSUE: Menu system operation and functions.

GDAS SUBSYSTEM: Menu.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: GDAS will include full menu-driven operation in all of its functions, and a command language bypassing the menu system. The analyst will have the option of using single key presses to navigate through the entire menu system.

TEST OBJECTIVE: Confirm that the GDAS Menu System operates as described in the GDAS Design Specification and satisfies the requirements described above. Other tests will provide opportunities to evaluate detailed menu functions, but this test will systematically explore the major functions of the main menu, the scenario menu, and the transportation model menu, and the utilities menu.

TEST PROCEDURES: Review the required function and the designed function of each menu option shortly before the test session. (Also consult user's manual if available.) Activate each function and observe the results. Repeat as necessary to confirm that the function operates as required.

DATA COLLECTION REQUIREMENTS: Observations on the functionality of each major menu function.

EVALUATION CRITERIA: The GDAS Menu System should include the functions required by the GDAS FD. Each menu function should operate as described in the GDAS Design Specification (or user's manual, if available).

GDAS IV&V TEST CASE # 1-21

IV&V ISSUE: Functions of interactive graphics system.

GDAS SUBSYSTEM: Transportation Model/Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: GDAS will maximize the use of graphics to illustrate progress as well as the results of the simulation. The graphics capability will consist of both Presentation Graphics and Transportation Graphics. The graphics capability will be linked with the DBMS.

TEST OBJECTIVE: Confirm that GDAS offers the required data manipulation and analysis capabilities. Evaluate the level of difficulty in data access, analysis, and output through GDAS interactive graphics. The GDAS Design Specification describes the required interactive graphics capabilities as "presentation graphics" and "transportation graphics" accessible under the transportation model menu. This test will focus on those functions.

TEST PROCEDURES: Review details of each graphics function in the GDAS Design Specifications and user's manual (if available) shortly before the function is to be tested. Use presentation graphics to display results of data searches and manipulations, including standard and ad hoc queries. Use transportation graphics to show deployment status at several time points in the simulation (from a previous run). Print samples of both tabular and graphical output for comparison with screen displays. Evaluate level of difficulty to produce graphics and quality of graphics for analysis.

DATA COLLECTION REQUIREMENTS: These tests can be performed with any existing GDAS output.

EVALUATION CRITERIA: All requirements described above should be satisfied by GDAS presentation graphics or transportation graphics. Graphics products should be suitable for analysis and presentation.

GDAS IV&V TEST CASE # 1-22

IV&V ISSUE: Exposure-related attrition of lift vehicles and cargo.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.14.

REQUIREMENT STATEMENT: Attrition submodels on travel links are expressed in terms of a search/attack/destroy exposure formulation using time dependent exponential attrition probabilities.

TEST OBJECTIVE: Confirm that the exposure-related attrition (on travel links) in GDAS operates as planned. The cargo actually on board an attrited vehicle should also be attrited.

TEST PROCEDURES: Query the output from one GDAS run where exposure-related attrition is enabled. The following steps should provide the necessary information:

- o Identify all attrited vehicles
- o Identify all cargo loaded on each vehicle at time of loss
- o Confirm that the identified cargo is attrited before reaching POD
- o Confirm that no other cargo is attrited before reaching POD.

DATA COLLECTION REQUIREMENTS: List of attrited vehicles and attrited cargo. Itineraries of attrited vehicles, including cargo loaded and unloaded at each stop.

EVALUATION CRITERIA: Three criteria will be used on this test:

- o The cargo loaded on the attrited lift vehicles at the time of attrition should not arrive at POD.
- o The quantity of cargo attrited should match the quantity of cargo loaded on the lift vessel at the time of its loss.
- o No other cargo should be removed from the simulation unless it is attrited at a port.

GDAS IV&V TEST CASE # 2-23

IV&V ISSUE: Aerial refueling on airlift missions.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS, para 5.4.1.

REQUIREMENT STATEMENT: GDAS transportation network nodes may represent origins, destinations, airports, seaports, truck or rail terminals, airdrop nodes, **air refueling points**, etc.

TEST OBJECTIVE: Verify aerial refueling capability for GDAS airlift missions.

TEST PROCEDURES: Choose a GDAS run in which airlift missions use refueling stops (e.g., CONUS to Persian Gulf). Create an aerial refueling node bisecting a long link such as the transatlantic leg. Run the model again and check the output for aircraft visiting the aerial refueling node.

DATA COLLECTION REQUIREMENTS: Identify the cargos on aircraft using the aerial refueling node and their transit time from POE to POD. Compare transit times for the same cargos (if airlifted) in the base run.

NOTE: Check whether this procedure would be simplified by using a "special mission."

EVALUATION CRITERIA: Aerial refueling nodes should be used in lieu of landing for fuel only. Airlift transit times (POE - POD) should decrease when aerial refueling is used.

GDAS IV&V TEST CASE # 2-24

IV&V ISSUE: Enroute refueling stops on airlift missions.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.8.

REQUIREMENT STATEMENT: Intermediate refueling stops are treated explicitly for airlift since refueling can significantly affect tradeoffs between average block speed versus payloads.

TEST OBJECTIVE: Confirm that GDAS airlift missions use enroute refueling stops by examining airlift itineraries in GDAS output data.

TEST PROCEDURES: Choose a run where distances between origin and destination for cargo traveling by airlift exceeds the input critical leg lengths of airlift assets. Select a movement requirement with cargo designated for airlift mode such that the origin to destination distance is greater than the input critical leg length for airlift assets. Identify the aircraft that moved the selected cargo and check their itineraries for stops where they only refuel and do not load or unload.

DATA COLLECTION REQUIREMENTS: Range at payload (table ACFTYPE) for each aircraft type. Requirement ID, cargo (or PAX) intertheater mode, origin, and destination from table REQUIRE. Latitude and longitude of origin and destination nodes from table NODEREF (to estimate total travel distance). Vehicles and trip numbers from table RPTITIN for all cargos related to the selected movement requirement. Stops and reasons for stops ("is unload?" and "is refuel?" data fields) in each trip from table STOP.

EVALUATION CRITERIA: Trip itineraries should contain enroute stops with "yes" for the "is refuel?" field and "no" for the "is unload?" field.

GDAS IV&V TEST CASE # 2-25

IV&V ISSUE: Routing of sealift missions.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.5.

REQUIREMENT STATEMENT: The GDAS planning process uses a multimodal, shortest path/dynamic programming algorithm to flow each movement across the transportation network and assign transport modes and routes based on nominal travel times and delays, without considering individual vehicle assignments. The planning process evaluates major tradeoffs between timely delivery of requirements and efficient use of costly vehicle assets in selecting modes and routes.

TEST OBJECTIVE: Confirm that the GDAS scheduler plans trips using the shortest available routes over the input Intermodal transportation network.

TEST PROCEDURES: Randomly select sealift trips with and without enroute load/unload stops from table STOP. Use the GDAS transportation graphics system, if available, to map each trip and all nodes available along the route from origin to destination. (Procedures for using transportation graphics are unknown.) If transportation graphics are not available, query latitude and longitude fields in table NODE to identify nodes along the route and cross-reference with table FACILITY to find sealift facilities. In cases where a shorter route appears to be available, check tables NODE, NODELINK, FACTYPE, and EXCLUDE to determine whether there are constraints that deny use of the node by that trip.

DATA COLLECTION REQUIREMENTS: The basic data requirements for this test are the trip data from table STOP and other available facilities along the route. The extent of data collection requirements will depend on the availability and functions of GDAS transportation graphics.

EVALUATION CRITERIA: The selected ship routes should be the shortest available route between cargo origin and destination.

GDAS IV&V TEST CASE # 2-26

IV&V ISSUE: Flexibility to define new vehicle types.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 5.2.

REQUIREMENT STATEMENT: GDAS includes capabilities to define, in the database, more detailed cargo types with additional units of measure, more detailed vehicle compartments (multiple compartments each having multiple units of measure and capacity limits with stow factors matched to cargo types).

TEST OBJECTIVE: Add a new vehicle type to a GDAS scenario and confirm that it is used by the model.

TEST PROCEDURES: Enter a new vehicle type in table VEHTYPE. For the purpose of the test, make its time and distance penalties low compared with other vehicles. Enter two types of compartments for the vehicle (tables VCPTTYPE and CPTTYPE) and use a different measure for each compartment (table CPTMEAS). Enter the compartment stow factors in table STOWFACT and stow penalties in table STOWPEN. Enter the vehicle characteristics in the appropriate table: ACFTYPE for airlift or SHIP for sealift. Table AIRSQUAD should be completed for an airlift vehicle. Hourly load and unload rates should be entered in table LOADRATE. Make a run and check that GDAS uses the new vehicle type (table RPTVTYPE).

DATA COLLECTION REQUIREMENTS: Obtain or develop vehicle capacities, characteristics, and stow factors before starting the test. Check for vehicle names and cargo quantities in table RPTVTYPE.

EVALUATION CRITERIA: GDAS should use the new vehicle type to transport cargo.

GDAS IV&V TEST CASE # 2-27

IV&V ISSUE: Compatibility of ships and seaports.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Facilities can be constrained as to whether refueling is permitted and which types of vehicles can be handled (e.g., C-17s may be unable to land at certain airports, or NATO fleets may be excluded from Korean seaports, or military aircraft only are permitted at airdrop facilities which have reduced unload rates).

TEST OBJECTIVE: Observe the matching of facilities and vehicles in GDAS.

TEST PROCEDURES: Check tables SEAPORT, EXCLUDE, and FACILITY to get the lift modes supported by each seaport facility and any vehicle or cargo exclusions. Use this information as a basis for searches in table RPTITIN to determine whether any prohibited matches occur among seaports, ships, and cargo categories. Ship draft, length, and beam (table SHIP) should also be compared with the maximum allowable at seaports.

DATA COLLECTION REQUIREMENTS: List of facilities that support sealift from table FACILITY. List of exclusions affecting these facilities from table EXCLUDE.

EVALUATION CRITERIA: No prohibited matches should occur.

GDAS IV&V TEST CASE # 2-28

IV&V ISSUE: Compatibility of aircraft and airports.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Facilities can be constrained as to whether refueling is permitted and which types of vehicles can be handled (e.g., C-17s may be unable to land at certain airports, or NATO fleets may be excluded from Korean seaports, or military aircraft only are permitted at airdrop facilities which have reduced unload rates).

TEST OBJECTIVE: Confirm that GDAS will not schedule aircraft to use airport facilities that do not meet aircraft requirements such as runway width, length, and composition, or facilities for specific aircraft types.

TEST PROCEDURES: Select a combination of aircraft type and airport in which the airport runway length is less than the minimum runway required for the aircraft. Set up a special mission (in table REQUIRE) for an air transportable movement requirement with the selected airport as its destination. Use tables MISSION and AIRSQUAD to assign a squadron of the selected aircraft to this special mission. Make a run and check output data to determine whether the cargo was transported, and if so, check the destination airport.

DATA COLLECTION REQUIREMENTS: Get airport runway length from table AIRPORT and aircraft runway requirement from table ACFTYPE. Get cargo movement dates and unload stop from table CARGO.

EVALUATION CRITERIA: The special mission aircraft should not fly the selected cargo into the selected airport.

GDAS IV&V TEST CASE # 2-29

IV&V ISSUE: Vehicle load and unload rates.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.6.

REQUIREMENT STATEMENT: Vehicle types and compartment types are defined generically for each transport mode in order to specify load rates, stow factors, refueling rates, and vehicle utilization penalties within a common structure for the scheduling model. Load and unload rates are specified as a function of vehicle type, facility type, and cargo type.

TEST OBJECTIVE: Confirm that GDAS loads and unloads lift assets at rates consistent with their input load/unload rates.

TEST PROCEDURES: Compile load/unload times and cargo quantities for all loading or unloading stops in a run. Divide cargo quantities by hourly load and unload rates for the vehicle type to determine whether the actual times are consistent with the input maximums.

DATA COLLECTION REQUIREMENTS: Ship name, cargo quantities, begin and end times, and port facility for each cargo load/unload activity from table RPTITIN. Ship type from table SHIP. Facility type from table FACILITY. Hourly load/unload rates from table LOADRATE.

EVALUATION CRITERIA: Computed actual load rates should not exceed input maximum load rates.

NOTE: The current data fields in the GDAS data dictionary indicate that the time loading operations begin and end is not reported. Only the begin and end dates are reported.

GDAS IV&V TEST CASE # 2-30

IV&V ISSUE: Facility throughput constraints for cargo.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Each facility has cargo or vehicle throughput measures based on facility type and transport mode, e.g., max cargo tonnage per day, max number of sorties or vehicles per day, and maximum on ground (for airlift) or in berth (for sealift).

TEST OBJECTIVE: Check sealift facility cargo loading and unloading activities by day to determine whether the facility throughput limits are exceeded.

TEST PROCEDURES: Cross-reference tables CARGO and STOP to get the start date, end date, and cargo quantity for each cargo loaded or unloaded at each sealift facility. Query the result for daily totals exceeding the facility limits (table FACLIMIT).

DATA COLLECTION REQUIREMENTS: Cargo quantity, load/unload days, and stop numbers from table CARGO. Facility name for each stop from table STOP. Facility limits from table FACLIMIT.

EVALUATION CRITERIA: Total cargo processed per day at any facility should not exceed the facility throughput limit.

GDAS IV&V TEST CASE # 2-31

IV&V ISSUE: Facility throughput constraints for vehicles.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Each facility has cargo or vehicle throughput measures based on facility type and transport mode, e.g., max cargo tonnage per day, max number of sorties or vehicles per day, and maximum on ground (for airlift) or in berth (for sealift).

TEST OBJECTIVE: Confirm that GDAS limits the number of ships per day using a seaport facility.

TEST PROCEDURES: Query table STOP in any GDAS scenario to find a seaport facility that is heavily used. In table FACILITY, change the Max Vehicles In Facility to two. Rerun the model to determine whether the vehicle throughput constraint was effective. (See test 3-73.)

DATA COLLECTION REQUIREMENTS: Get the facility node, vehicle arrive day, and vehicle depart day from table STOP.

EVALUATION CRITERIA: There should not be more than two ships at the selected seaport facility on any one day.

GDAS IV&V TEST CASE # 2-32

IV&V ISSUE: User-specified cargo packaging criteria.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 5.17.

REQUIREMENT STATEMENT: The query capability of the underlying database can be used to perform packaging based on user-specified criteria. First the CAA analyst is able to select or query any subset of movement requirements (e.g., Air Force resupply) before applying a given set of packaging rules. The analyst can use the database query tools to redefine or merge cargo categories prior to packaging if a more aggregated analysis is desired.

TEST OBJECTIVE: Use GDAS database capabilities to package a set of movement requirements.

TEST PROCEDURES: To be determined. Table PARAM has fields to input a number of days to use as a RLD packaging range or as a RDD packaging range. There is apparently no straightforward capability to package specific movement requirements within GDAS. (The capability to redefine cargo categories is available, but the original input categories would be lost.)

DATA COLLECTION REQUIREMENTS: To be determined. The appropriate data fields and data entry procedures must be obtained from additional GDAS documentation or from the model developers.

EVALUATION CRITERIA: To be determined. The primary criterion for this test should be based on delivery profiles of packaged cargo. A secondary criterion may be used for visibility of the cargo delivery dates at different aggregation levels (UIC, TPSN, etc.).

GDAS IV&V TEST CASE # 2-33

IV&V ISSUE: Analyst-assigned cargo transport modes.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.3.

REQUIREMENT STATEMENT: Movement requirements may exhibit relationships which must be coordinated during scheduling. For example, movements may have pre-assigned transport modes, POE/POD ports, or staging nodes with a predefined ALD (Available to Load Date), EAD (Earliest Arrival Date), and LAD (Latest Arrival Date) as specified in the REQNODE table.

TEST OBJECTIVE: Confirm that GDAS complies with specific lift modes input by the user.

TEST PROCEDURES: Perform this test by modifying an existing GDAS scenario. Randomly select movement requirements that normally travel via airlift (e.g., PAX) and assign them a Cargo Intertheater Mode of sealift (table REQUIRE). Randomly select movement requirements that normally travel via sealift (e.g., bulk ammunition) and assign them a Cargo Intertheater Mode of airlift. Run the modified scenario and check whether the lift mode for the selected movement requirements complied with the input assignments (use table RPTITIN).

DATA COLLECTION REQUIREMENTS: Data from any existing GDAS scenario can be used for this test.

EVALUATION CRITERIA: Each cargo associated with the selected movement requirements should be transported by the assigned lift mode.

GDAS IV&V TEST CASE # 2-34

IV&V ISSUE: Analyst-assigned cargo staging stops.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.3.

REQUIREMENT STATEMENT: Cargo movements may have pre-assigned transport modes, POE/POD ports, or staging nodes with a predefined ALD (Available to Load Date), EAD (Earliest Arrival Date), and LAD (Latest Arrival Date) as specified in the REQNODE table. If multiple requirements are staged or assembled together then an assembly dependency exists in which successor cargos are delayed until all predecessor cargos arrive, possibly with delay times for assembly and a latest staging depart day as specified in the STAGE table.

TEST OBJECTIVE: Confirm that GDAS allows analysts to link movement requirements for consolidation or assembly at a specific node.

TEST PROCEDURES: Select movement requirements with similar RDDs to be consolidated during a run. Enter the requirements in table REQNODE and assign a stage name. Select an intermediate staging node with appropriate facilities and compute a node EAD, LAD, and delay time consistent with the RDD and distance to destination. Enter the delay days and stage latest depart day in table STAGE. Run the scenario and check the load stops, unload stops, and related dates in table CARGO to determine whether GDAS complied with the input staging parameters.

DATA COLLECTION REQUIREMENTS: Described in test procedures.

EVALUATION CRITERIA: Each cargo associated with the selected requirements should transit the staging node during the input staging dates. (NOTE: Cargos need not visit the staging node after the latest depart date in table STAGE.)

GDAS IV&V TEST CASE # 2-35

IV&V ISSUE: Special mission assignments for lift assets.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.8.

REQUIREMENT STATEMENT: Special missions can be defined which restrict aircraft squadrons, ship fleets, or individual ships to a particular set of movement requirements for a specified period of time.

TEST OBJECTIVE: Check out the GDAS special mission feature that reserves ships to transport only cargo designated by the special mission code. (Special mission for airlift is used in another test.)

TEST PROCEDURES: Set a special mission code for a large movement requirement in table REQUIRE. Use tables MISSION and SHIP to assign only one ship for the special mission cargo. Check table RPTITIN to identify the vehicle(s) moving the cargo.

DATA COLLECTION REQUIREMENTS: Locate cargo by requirement ID in table RPTITIN and get the name of the ship transporting the cargo from the same table.

EVALUATION CRITERIA: Special mission cargo should be transported only on the special mission ship.

GDAS IV&V TEST CASE # 2-36

IV&V ISSUE: Scheduler compliance with input movement dates.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.1.

REQUIREMENT STATEMENT: The planning phase introduces a concept referred to as the Target Lift Date (TLD). The TLD is computed for each movement requirement, and is that date at which the movement requirement must begin its journey to its destination in order to arrive by the Required Delivery Date (RDD).

TEST OBJECTIVE: Confirm that the GDAS scheduler complies with input cargo availability dates and required delivery dates.

TEST PROCEDURES: Use the input RLD, EDD, and RDD (table REQUIRE) as measures for this test. Query tables CARGO, REQUIRE, and RPTITIN to compute the difference between input cargo movement dates and simulated cargo movement dates.

DATA COLLECTION REQUIREMENTS: Data from any existing GDAS scenario can be used to perform this test.

EVALUATION CRITERIA: The input cargo movement dates and simulated movement dates should have the following relationships:

- o $RDD - \text{Cargo Delivery Day} \geq 0$
- o $\text{Cargo Delivery Day} - EDD \geq 0$
- o $\text{Begin Load Day} - RLD \geq 0$

GDAS IV&V TEST CASE # 2-37

IV&V ISSUE: Time-stepped changes for input parameters.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.13.

REQUIREMENT STATEMENT: The analyst has the ability to make any characteristics data change over time in a surprise mode for the transportation model. For example, total port throughput can be edited to change over time on several different dates, or sealift links may change over time to reflect canal closings. In the simulation model, the time-varying changes are incorporated into the packed data itself on a daily basis, so subsequent accesses return the changed value. These changes may require re-planning or re-scheduling of future cargo assignments in the logic.

TEST OBJECTIVE: Confirm that GDAS users can input variations in transportation system capabilities for specific time periods.

TEST PROCEDURES: Use table FACILITY to test this feature. Select the Time Vary option from the Setup menu and set the Operating Hours/Day for a major port facility (or several facilities) to zero over a period of several days, then back to the starting value. Run the modified scenario and check table STOP to determine whether the facility was used on open days and not used on closed days.

(QUESTION: What data is considered "characteristics data?"

DATA COLLECTION REQUIREMENTS: Data from any GDAS scenario can be used to perform this test.

EVALUATION CRITERIA: The selected facility should not be used while its operating hours are set at zero, but should be used before and after this period.

GDAS IV&V TEST CASE # 2-38

IV&V ISSUE: Variable weights to accompany airlifted PAX.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS COTR.

REQUIREMENT STATEMENT: Could not find this requirement in FD or SDS.

TEST OBJECTIVE: Confirm that GDAS has the capability to assign the baggage weight accompanying airlifted passengers.

TEST PROCEDURES: To be determined. It should be possible to select requirements with large number of passengers and change the accompanying weight. The accompanying weight for this test should be selected to ensure that an aircraft like a C-141 would reach maximum payload weight before the maximum number of passengers is loaded. As a result, a C-141 transporting passengers for the selected requirement would carry less than the maximum number of passengers.

DATA COLLECTION REQUIREMENTS: Table CARGOCLAS has a field named "Has Accompanying Pounds?" Table THTRREQ has a field named "Accompanying Gear" for non-carry-on accompanying gear per passenger. It is not clear that these fields have any effect on the loading of lift vehicles.

EVALUATION CRITERIA: To be determined. The evaluation criteria should be based on the expected GDAS response to input data changes specified by the test procedures.

GDAS IV&V TEST CASE # 2-39

IV&V ISSUE: User control of scheduling goals.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.7, 5.8.

REQUIREMENT STATEMENT: A variety of penalty factors are used to evaluate alternative cargo/ship assignments for scheduling. These penalty factors define tradeoffs between multiple objective function criteria such as cargo timeliness and ship utilization. Each penalty factor is designed to control a separate aspect of ship scheduling. . . Aircraft scheduling is performed with the same overall approach as sealift, with the calculation of marginal cost/benefit ratios to determine preferred aircraft selections.

TEST OBJECTIVE: Confirm that factors designed to provide analyst control of the GDAS scheduler are effective in meeting the scheduler goals. These factors include the following:

- o Analyst RDD
- o Penalty factors
- o Scheduling horizon
- o Constraints
- o Prioritization.

TEST PROCEDURES: The information about these factors in the GDAS SDS leaves many open questions about the practical range of values for each factor, the interactions among factors, and the output measures affected by each factor. Tests of these factors will involve parametric variation of a single factor and observation of the changes in an appropriate MOE. Where possible, the run-to-run changes will be compared in both tabular and graphical form. Standard GDAS output reports will be used to the maximum extent possible.

DATA COLLECTION REQUIREMENTS: To be determined, based on additional GDAS documentation or on the results of initial model runs.

EVALUATION CRITERIA: The nature of GDAS response to changes in the above factors should be consistent over a range of values. Changing a factor should, within the range of model sensitivity, should cause a proportional (or inversely proportional) response in the MOE of interest.

GDAS IV&V TEST CASE # 2-40

IV&V ISSUE: Notional intratheater transport delays.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.2.

REQUIREMENT STATEMENT: The GDAS design explicitly accounts for the coordination of multiple, interdependent movements which are characteristic of DoD intermodal transportation, including cargos which are related by precedence sequencing (e.g., a multimodal staged movement in which an airlift leg depends on a prior sealift leg), or assembly dependency (e.g., multiple air/sea or POMCUS movements which must marry up at a marshalling or staging location before moving forward), or balanced force links (e.g., CS/CSS/supply movements which are assigned to support a combat unit).

TEST OBJECTIVE: Confirm that GDAS has the capability to represent in-theater activities such as assembly delays in marshalling areas.

TEST PROCEDURES: Need to calculate the difference between Cargo Delivery Day and Cargo Unload Day (table RPTITIN), change selected marry-up delay days in table THTRREQ, run the modified scenario, and run the modified scenario. The difference between delivery day and unload day should reflect the change in marry-up delay days. (QUESTION: How can you make a connection between Requirement ID and Requirement Type?)

DATA COLLECTION REQUIREMENTS: As described in the test procedures.

EVALUATION CRITERIA: Marry-up delay days should be reflected in the difference between cargo unload day and cargo delivery day.

GDAS IV&V TEST CASE # 2-41

IV&V ISSUE: Dynamic intratheater resupply algorithm.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.12.

REQUIREMENT STATEMENT: Resupply demands are generated daily as units arrive and deploy at the destination based on consumption rates specified in the database. Demand is met first from accompanying (unit) supplies, then from stockpiles at the destination. Each destination stockpile has a specified reorder level, minimum economic order quantity, and a target inventory level for total on hand plus on order, all of which are used to place "orders" at supply origins when stockpiles are drawn down to the reorder level. The orders are placed with the nearest supply origin (based on shortest path calculations) that has sufficient supply quantity, resulting in the dynamic generation of resupply movement requirements. If at any time the stockpiles in the theater are insufficient to meet demands, the demands are simply dropped with no backlogging in the current formulation.

TEST OBJECTIVE: Confirm that GDAS generates and fills intratheater resupply demands.

TEST PROCEDURES: Daily consumption rates and accompanying days of supply can be entered in table SUPPCONS. Combat intensity and supply attrition can be entered in table SUPPINT. The resupply origins and their production rates are entered in table SUPPORIG. Stockpile destinations and order quantities are in table SUPPDEST. Table PARAM has a "Do Dynamic Resupply?" field used to activate the dynamic resupply process. Table REQTYPE has a "Generate Resupply?" field that designates the requirement types for which resupply will be generated. (QUESTION: What controls the movement and disposition of resupply orders?)

DATA COLLECTION REQUIREMENTS: Need data to fill the applicable fields described in the test procedures. First step is to precisely identify which fields affect dynamically generated resupply requirements.

EVALUATION CRITERIA: To be determined. Evaluation criteria for this test should be based on the data changes prescribed in the test procedures.

GDAS IV&V TEST CASE # 2-42

IV&V ISSUE: Simulation of airdrop operations.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.1.

REQUIREMENT STATEMENT: GDAS transportation network nodes may represent origins, destinations, airports, seaports, truck or rail terminals, **airdrop nodes**, air refueling points, etc.

TEST OBJECTIVE: Confirm the GDAS airdrop capability.

TEST PROCEDURES: Set up a movement requirement in table REQUIRE for air transport mode, using an airdrop facility (may have to create the facility) as the final destination. Check output in table RPTITIN to determine the cargo unload stop, unload day, and delivery day.

DATA COLLECTION REQUIREMENTS: Get the cargo unload stop, unload day, and delivery day from table RPTITIN.

EVALUATION CRITERIA: Cargo should be unloaded at the airdrop facility and the delivery date should be the same as the unload date.

GDAS IV&V TEST CASE # 2-43

IV&V ISSUE: Convoy control parameters by theater.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.10.

REQUIREMENT STATEMENT: Data elements which specify conveying policy for ships are listed in Figure 5-9. (NOTE: The data elements include convoy assembly and disassembly nodes in table CONVOY, and a convoy begin day in table THEATER.) If a movement requirement has a destination in a theater for which conveying operations have begun, and if a given ship must be convoyed based on the convoy speed criterion, then a separate calculation is performed to identify the nearest convoy assembly node and disassembly node based on great circle distances.

TEST OBJECTIVE: Confirm that GDAS dynamically forms ship convoys according to parameters input by the user.

TEST PROCEDURES: Set flags in table PARAM to do conveying and (optionally) convoy returning ships. Enter dates to begin convoys and maximum ship speed to be convoyed in table DESTIN (per GDAS Data Dictionary, 19 Dec 90) for selected destinations. All other input information for convoys is entered in table CONVOY: min and max numbers of ships and escorts, convoy speed and delay days, and assembly and disassembly nodes. Convoy output is in table CONVTRIP.

DATA COLLECTION REQUIREMENTS: Described in the test procedures.

EVALUATION CRITERIA: Ships going to the selected destinations during the conveying period should travel in convoys unless they exceed the limitations for ship speed or waiting time.

GDAS IV&V TEST CASE # 2-44

IV&V ISSUE: Cargo staging in multi-mode transportation.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.3.

REQUIREMENT STATEMENT: Cargo movements may have pre-assigned transport modes, POE/POD ports, or staging nodes with a predefined ALD (Available to Load Date), EAD (Earliest Arrival Date), and LAD (Latest Arrival Date) as specified in the REQNODE table. If multiple requirements are staged or assembled together then an assembly dependency exists in which successor cargos are delayed until all predecessor cargos arrive, possibly with delay times for assembly and a latest staging depart day as specified in the STAGE table.

TEST OBJECTIVE: Confirm that staged cargo can use different lift modes departing a staging node than they used to get to the staging node.

TEST PROCEDURES: This test can be performed concurrently with test 2-34. The Required Mode to Node field in table REQNODE should be completed for this test. (NOTE: There is no place to input a required mode from the staging node.) (QUESTION: How can the transport modes in and out of the staging node be checked? Tables CARGO and STOP?)

DATA COLLECTION REQUIREMENTS: Described in test 2-34.

EVALUATION CRITERIA: Some of the staged cargo should use different transport modes before and after the staging node. Anticipate that cargo airlifted to the staging node may depart by sealift.

GDAS IV&V TEST CASE # 2-45

IV&V ISSUE: Tracking individual aircraft in output data.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.9.

REQUIREMENT STATEMENT: Each voyage or trip has an itinerary which is defined in terms of stops at ports or nodes. For each stop, the output data includes arrive day, node or port, facility type, depart day, and whether the stop is for unloading. . . For each trip, the assigned vehicle type and, as appropriate, the assigned ship or air squadron are stored.

TEST OBJECTIVE: Confirm that analysts can follow the utilization of a specific aircraft in a GDAS simulation.

TEST PROCEDURES: Link table TRIP and table STOP to determine the itineraries of aircraft on missions. Slack time for a specific aircraft is not directly available -- only total vehicles unused or in slack by vehicle type (table RPTVEHDY). Percent fill of aircraft is only available as an average by vehicle type in table RPTVTYPE. (Percent fill for ships is available in table RPTITIN, but aircraft are not included in this table.)

DATA COLLECTION REQUIREMENTS: Output data from any GDAS scenario can be used to perform this test.

EVALUATION CRITERIA: The location, activity, and percent fill of any individual aircraft at any time in a GDAS simulation should be available in GDAS output.

GDAS IV&V TEST CASE # 2-46

IV&V ISSUE: Use of multiple ports in sealift missions.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.5.

REQUIREMENT STATEMENT: The scheduling algorithm evaluates the cargo characteristics and the currently scheduled vehicle itineraries to assign the cargo to vehicles or transport assets, using detailed route insertion algorithms and "greedy cargo" cost/benefit selection for airlift and sealift.

TEST OBJECTIVE: Confirm use of multiple pickup and delivery stops for GDAS sealift missions.

TEST PROCEDURES: Sort table RPTITIN by ship name, trip number, and arrive day. Check port names and the "is unload?" field to identify loading and unloading stops in each trip for randomly selected ships. Also check the field "ship load % after stop" to determine when each ship is full.

DATA COLLECTION REQUIREMENTS: Get ship names, trip numbers, stop ports, and "is unload?" data from table RPTITIN.

EVALUATION CRITERIA: Expect ships that are lightly loaded at the beginning of a trip to make additional loading stops. Any ship may make multiple unloading stops, depending on cargo destination(s).

GDAS IV&V TEST CASE # 2-47

IV&V ISSUE: Analyst control of closure criteria.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.16.

REQUIREMENT STATEMENT: Calculation of closure dates are based on user-specified delivery percentages by requirement type, and are computed automatically at the end of the model process. Closure dates are computed at various levels including UIC, movement requirement, unit match code, and requirement TPSN for major unit closure.

TEST OBJECTIVE: Use GDAS control parameters to compute unit closures at different levels such as UIC versus major unit.

TEST PROCEDURES: Enter predetermined values for "closure required cargo %" and for "closure required PAX %" for a selected requirement type in table REQTYPE. Calculate the quantities of cargo and PAX that must be delivered to achieve closure for a randomly selected requirement of this type in table REQUIRE. Make a run and sum the cargo quantity delivered up to the computed closure day in table RPTREQ for the preselected requirement. Compare the precomputed closure quantities with the sums from table RPTREQ.

DATA COLLECTION REQUIREMENTS: Requirement type for test from table REQTYPE. Cargo and PAX quantities from table REQUIRE. Computed closure date and cargo (PAX) quantities, from table RPTREQ.

EVALUATION CRITERIA: Precomputed closure quantities should match the summed quantities as of the computed closure day.

GDAS IV&V TEST CASE # 2-48

IV&V ISSUE: Display of cargo delivery profiles over time.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 4.3.2.

REQUIREMENT STATEMENT: GDAS results consists of graphical and tabular outputs. The tabular outputs include cargo delivery dates, deviation of delivery date from RDD for each package, and the amount of cargo in each category processed. Graphical outputs include bar graphs and line graphs showing profiles of required versus delivered cargo by cargo category for each node; daily shortfall in ammunition, resupply, POL, and unit equipment for each POD; and a Gantt chart depicting the major combat unit closure profiles.

TEST OBJECTIVE: Confirm that delivery of cargo at destination can be readily reviewed by users at various levels of aggregation.

TEST PROCEDURES: Use the Check Results menu and the Report menu under the Transportation Model menu to review the standard output tables and charts showing cargo delivery profiles. Query table RPTREQ to determine the type of information available for ad hoc reports or calculations.

DATA COLLECTION REQUIREMENTS: Output data from any GDAS scenario can be used to perform this test.

EVALUATION CRITERIA: As a minimum, cargo delivery profiles should be available by major units and by requirement ID.

GDAS IV&V TEST CASE # 2-49

IV&V ISSUE: Utilization of lift assets over time.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 5.16.

REQUIREMENT STATEMENT: Various MOEs will be incorporated into the GDAS prototype through the development of useful queries which are enhanced by graphical illustrations. These include detailed ship itineraries including port visits and cargo load/unload activities; detailed port activities including ship arrivals and cargo load/unload dates; and summary totals of ships and aircraft used.

TEST OBJECTIVE: Determine whether the GDAS FD output requirements for lift asset utilization are met by GDAS output. (See test 3-74.)

TEST PROCEDURES: Examine data in tables RPTITIN, RPTREQ, RPTVEHDY, and RPTVEHTYPE to determine whether all data required by the FD is present.

DATA COLLECTION REQUIREMENTS: Output data from any GDAS simulation can be used to perform this test.

EVALUATION CRITERIA: All required data should be easily accessible to the analyst.

GDAS IV&V TEST CASE # 2-50

IV&V ISSUE: Compare summary tables with raw data.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 5.16.

REQUIREMENT STATEMENT: Comprehensive details of the scheduling results are stored in the output database. The analyst can query out any measure of closure or delivery effectiveness desired, ranging from summary totals down to the UIC level. Additionally, CAA defined standardized queries and reports for major unit closure, as well as total delivery summary profiles, will be developed.

TEST OBJECTIVE: Compare the results of ad hoc queries on raw GDAS output data with values from the standard summary data reports provided in the GDAS data base for the following MOEs:

- o Ship utilization
- o Aircraft utilization
- o Cargo deliveries
- o Cargo lateness.

TEST PROCEDURES: Examine the data provided in each of the standard reports described above. Trace the source of several data items back to the tables containing the raw data (using the GDAS data dictionary). Use ad hoc queries to perform the same types of operations on the raw data.

DATA COLLECTION REQUIREMENTS: To be determined. Depends on the data available in the standard reports.

EVALUATION CRITERIA: Results of ad hoc queries should be the same as in the standard GDAS output reports.

GDAS IV&V TEST CASE # 2-51

IV&V ISSUE: Hourly output on port activities.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.1.1.

REQUIREMENT STATEMENT: Output involving time will be precise to the nearest day, although internal airlift and sealift time calculations will be performed on an hourly basis. The accuracy of the input data is not sufficient to yield precision greater than one day (e.g., when a unit is "ready to load" is not really known even to the nearest day).

TEST OBJECTIVE: Track the activities of a specific GDAS entity (cargo, lift asset, or facility) in sufficient detail to determine what it was doing at any point in a simulation run. Examples:

- o Lift vehicle itinerary
- o Port facility activities (berths, etc.)
- o Cargo movement itinerary.

TEST PROCEDURES: Not applicable. Tables FACEVNT and RPTFACIL show the day at which a change in facility resources or capacity changes. All GDAS time output is in units of days, which makes it impossible to analyze hourly changes.

DATA COLLECTION REQUIREMENTS: Not applicable. According to the GDAS SDS, hourly output on any activity in the GDAS simulation is explicitly excluded from the design.

EVALUATION CRITERIA: Not applicable. According to the GDAS SDS, hourly output on any activity in the GDAS simulation is explicitly excluded from the design.

GDAS IV&V TEST CASE # 3-52

IV&V ISSUE: Precision of GDAS calculations.

GDAS SUBSYSTEM: Database/Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.1.1.

REQUIREMENT STATEMENT: Internal calculations will have precision to produce a minimum five significant digits of output. Additionally, output involving tonnage figures will be precise to the nearest ton so that cumulative figures will be accurate. Output involving time will be precise to the nearest day, although internal airlift and sealift time calculations will be performed on an hourly basis.

TEST OBJECTIVE: Survey GDAS input and output data for indications that the model does not provide the required precision. Internal GDAS calculations will not be checked in this test.

TEST PROCEDURES: This test will be performed concurrently with other tests that require examination or manipulation of GDAS input and output data. The primary indication of inadequate precision would be an instance of data fields sized too small to accept values that could be input or calculated. If such problems are noted, they will be documented and accumulated for evaluation as part of this IV&V test.

DATA COLLECTION REQUIREMENTS: Record indications of inadequate precision while performing other IV&V tests.

EVALUATION CRITERIA: GDAS numerical fields should support the required precision (e.g., five to nine or more significant digits).

GDAS IV&V TEST CASE # 3-53

IV&V ISSUE: Turnaround time for a GDAS simulation.

GDAS SUBSYSTEM: Database/Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.2.

REQUIREMENT STATEMENT: **Simulation run time.** A scenario consisting of 20,000 movement requirements and 1,000 air/sea nodes and parts in the transportation network will take approximately 4 hours to run on an Intel 80486 machine with 32-bit compiled source code, depending on the level of detail of the analysis.

TEST OBJECTIVE: Determine whether the turnaround time for an average GDAS run satisfies the functional requirement above. For the purpose of this test, an average run will be an excursion from a base case that has already been set up and has executed successfully.

TEST PROCEDURES: Timing data will be collected from other tests which require that input data is changed for a model run and the output data be reviewed to assess the effect of the input changes. The tests to be used for this purpose will be selected before their execution. Clock time will be noted at the beginning and end of data preparation, at the beginning and end of procedures required to set up and execute a model run, at the beginning and end of the model run, and at the beginning and end of data analysis (including time for printouts if multiple scenarios must be compared). The times recorded for at least five runs will be first summed for each run, then averaged across the runs to compute a representative GDAS turnaround time.

DATA COLLECTION REQUIREMENTS: Record times as described in the test procedures. Note characteristics of each run that indicate the extent of differences (number of input data tables edited, number of output reports examined). Note the nature and duration of any interruptions during each test.

EVALUATION CRITERIA: The computed average turnaround time should not exceed four hours. (Notes on the differences between timed tests may be used to judge whether a particular test should be considered representative of GDAS turnaround procedures.)

GDAS IV&V TEST CASE # 3-54

IV&V ISSUE: Maximum size of GDAS deployment scenarios.

GDAS SUBSYSTEM: Data Base, Transportation Model, Presentation and Transportation Graphics.

REQUIREMENT SOURCE: GDAS FD para 3-3.a (not in SDS).

REQUIREMENT STATEMENT: The largest scenario will involve approximately 40,000 movement requirements, 1,300 aircraft, 1,500 ships, 30 ports of embarkation (POEs), and 60 ports of debarkation (PODs).

TEST OBJECTIVE: Perform stress testing at the maximum required GDAS scenario capacity for movement requirements, ports, and strategic lift resources. This test will help to assess whether large-scale scenarios cause any problems in running GDAS.

TEST PROCEDURES: Analyze existing GDAS scenarios to find one with large scale deployments to multiple theaters. (If none exists, create one.) Replicate and add data items as required to reach the scenario size given in the requirement statement. Run the model (record run time, ref. page 3-56) and examine several standard output measures to assess whether the output appears complete and normal. If difficulties occur on the first attempt, recheck the referential integrity of the input data to determine whether input errors caused the problems.

DATA COLLECTION REQUIREMENTS: The only data to be collected for this test is any additional data needed to amplify the input scenario data. Model run time should be recorded as a probable indication of the maximum run time expected of a GDAS scenario.

EVALUATION CRITERIA: The model should execute normally and produce output showing appropriate utilization of lift assets and transportation of movement requirements.

GDAS IV&V TEST CASE # 3-55

IV&V ISSUE: DBMS query response times.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.2.

REQUIREMENT STATEMENT: The DBMS response time for a simple menu-driven query will be within 15 seconds for small tables. When presented with the most complex query using Structured-Query-Language (SQL), the response time will be considerably longer depending on the table sizes and key field cross-references.

TEST OBJECTIVE: Confirm that the GDAS data base response times comply with the requirement statement.

TEST PROCEDURES: After a successful model run of a multiple-theater scenario, go to the Query function of the GDAS Transportation Model. Execute all queries available under the menu panel, obtaining overall totals as often as possible. Record the time from selection of a query until its results are displayed on the screen. Tabulate the response times to determine the maximum DBMS menu-driven query response time. For assessment of the ad hoc query response times, the queries generated to calculate results should be timed and the results tallied to determine the maximum response time.

DATA COLLECTION REQUIREMENTS: Record query response times. (The nature of each query may be optionally recorded for possible categorization of query response times.)

EVALUATION CRITERIA: The maximum menu-driven query response time should be 15 seconds or less. The maximum ad hoc query response time should be 5 minutes or less.

GDAS IV&V TEST CASE # 3-56

IV&V ISSUE: Run time for a complex scenario.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.2.

REQUIREMENT STATEMENT: A scenario consisting of 20,000 movement requirements and 1,000 air/sea nodes and parts in the transportation network will take approximately 4 hours to run on an Intel 80486 machine with 32-bit compiled source code, depending on the level of detail of the analysis.

TEST OBJECTIVE: Confirm that GDAS can run a complex, large scale scenario within the time given in the requirement statement.

TEST PROCEDURES: This test can be performed concurrently with test 3-54. The additional step required for this test is to record the time at the beginning of the model run and at the end of the model run. (QUESTION: Can the system time be recorded automatically?)

DATA COLLECTION REQUIREMENTS: Record the start time and end time for the model run.

EVALUATION CRITERIA: The run time should not exceed 10 hours.

GDAS IV&V TEST CASE # 3-57

IV&V ISSUE: Operation of the main menu system.

GDAS SUBSYSTEM: Menu.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The analyst, in interacting with the system, will be able to make selections from a set of choices on a menu, and update/change/create data through clearly defined data entry and manipulation screens.

TEST OBJECTIVE: Confirm that all actions required to input and edit scenarios, run the transportation model, and analyze the model output can be performed from the GDAS menu system.

TEST PROCEDURES: Activate each option in the initial GDAS menu to assess their operation. Menu items subordinate to the "select scenario" option will be used repeatedly in other tests and discrepancies will be documented as they occur. All discrepancies related to the GDAS command menu should be summarized under this test.

DATA COLLECTION REQUIREMENTS: Observe operation of the GDAS menu system and record discrepancies.

EVALUATION CRITERIA: Each menu selection should perform the indicated action.

GDAS IV&V TEST CASE # 3-58

IV&V ISSUE: Operation of the transportation model menu system.

GDAS SUBSYSTEM: Menu.

REQUIREMENT SOURCE: GDAS SDS para 4.1.4.

REQUIREMENT STATEMENT: The analyst has many of the same features available as are present under the GDAS Movement Requirement Generation Menu (ref SDS paragraph 4.1.3). The "Setup" menu option also attempts to reduce the complexity of the model, but affects very different data types worth mentioning here. Executing "Setup" displays multi-table form(s) that prompt for gross characteristics such as whether or not attrition or convoying should be modeled. It also prompts for input values for the planning horizon, time variations, parametric and stochastic analysis factors, unit closure percentage, and penalty factors.

TEST OBJECTIVE: Confirm that all actions required to input and edit scenarios, run the transportation model, and analyze the model output can be performed from the GDAS menu system.

TEST PROCEDURES: This test will be conducted concurrently with other tests that require use of the scenario menu system. Any discrepancies noted during normal operation of the scenario menu selections will be accumulated for this test.

DATA COLLECTION REQUIREMENTS: Record discrepancies observed during GDAS menu operations.

EVALUATION CRITERIA: Scenario menu options should implement the indicated actions.

GDAS IV&V TEST CASE # 3-59

IV&V ISSUE: Operation of the utility menu system.

GDAS SUBSYSTEM: Menu.

REQUIREMENT SOURCE: GDAS SDS para 4.1.5.

REQUIREMENT STATEMENT: The "Utility" menu offers an assortment of system maintenance related functions such as checking data consistency, import, export, backup, and restore.

TEST OBJECTIVE: Check the operation of ancillary functions provided in the GDAS utility menu system such as importing and exporting data, checking the referential integrity of a scenario, and the capability to backup and restore data.

TEST PROCEDURES: To be determined. The GDAS Utility menu is discussed in SDS paragraphs 4.1.5 and 4.2.1, but the discussion does not contain sufficient detail to generate test procedures.

DATA COLLECTION REQUIREMENTS: To be determined. No specific data should be required to perform this test. Discrepancies should be documented and reported as test results.

EVALUATION CRITERIA: To be determined. Menu selections in the final GDAS software may differ from the SDS description, but each menu item should produce the indicated response.

GDAS IV&V TEST CASE # 3-60

IV&V ISSUE: Help screens available with menu items.

GDAS SUBSYSTEM: Menu.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: Each screen presented to the user will include help which provides sufficient information to enable the analyst to continue with a desired operation. In addition, the User's Manual will be on-line to supplement the help system.

TEST OBJECTIVE: Confirm that help screens are available throughout the GDAS menu system and that the information they contain helps the user to complete the operation in progress.

TEST PROCEDURES: This test is closely related to the main menu test. The designated Help key will be pressed at each new menu screen to determine whether help panels are available. The content of each available help panel will be assessed with regard to its helpfulness in performing the operations available under the selected menu panel. References to the user's manual will be spot-checked to determine their accuracy. Explain the nature of any discrepancies encountered.

DATA COLLECTION REQUIREMENTS: Document whether help panels are available at each menu screen. Record an assessment of whether each help panel is useful. Indicate when references to the user's manual are checked and whether those checked are accurate. Record the nature of discrepancies discovered at any point in the test.

EVALUATION CRITERIA: Help panels should be available at each menu screen. Each help panel should contain reminders or helpful hints about the options available on the associated menu screen. References should be available to direct the user to the appropriate section of the user's manual for more information on each item.

GDAS IV&V TEST CASE # 3-61

IV&V ISSUE: Worldwide simulation of independent theaters.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The model will include the capability for an unlimited number of theaters or contingency areas.

TEST OBJECTIVE: Enter movement requirements destined for eight different theaters and confirm that GDAS can transport all requirements.

TEST PROCEDURES: Obtain or generate locations of eight theaters (check that routes to each theater are available in GDAS data). Obtain or generate a set of movement requirements destined for each theater. Run the model and check output reports to confirm that cargo is delivered to each theater.

DATA COLLECTION REQUIREMENTS: Data for port facilities in each theater. Time phased data for movement requirements destined to each theater. Standard GDAS output reports of cargo requirements versus deliveries.

EVALUATION CRITERIA: Movement requirements should be delivered to their respective theaters.

GDAS IV&V TEST CASE # 3-62

IV&V ISSUE: CONUS mobilization and intratheater delays.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: GDAS will simulate movement requirements of all items from origin through POEs, to and through PODs, to destinations in each theater.

TEST OBJECTIVE: Confirm that GDAS simulates movement of cargo from origin to POE and from POD to destination.

TEST PROCEDURES: To be determined. The GDAS SDS states that the target lift date (TLD) considers the entire movement requirement from origin to POE, to and through POD, to destination. The GDAS data dictionary does not show the TLD as an output field, so it may not be possible to confirm the transportation time between origin and POE. The data dictionary does contain fields for cargo unload date (at SPOD) and cargo delivery date (at destination), so the difference between these dates can be used to compute intertheater transportation delays for sealifted cargo. There is no indication of cargo delivery dates for airlifted cargo. (NOTE: GDAS apparently does not allow cargo to form a queue at a POE.)

DATA COLLECTION REQUIREMENTS: For each cargo, obtain the distance from origin to POE and from POD to destination. Obtain marry-up times from table THTRREQ. Compute the difference between the TLD (if available) and the Cargo Load Day (table RPTITIN) as CONUS movement time. Compute the difference between the Cargo Unload Day and Cargo Delivery Day (table RPTITIN) as the intratheater movement time.

EVALUATION CRITERIA: CONUS and intratheater movement times should be proportional to the distances traveled to POE and from POD. Intratheater times should also include marry-up delay days.

GDAS IV&V TEST CASE # 3-63

IV&V ISSUE: Dynamic generation of medical evacuation, noncombatant evacuation (NEO), and retrograde cargo.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS FD para 3-4.b.(3)(c)4.h (not in SDS).

REQUIREMENT STATEMENT: Retrograde cargo (as a function of number of soldiers in theater) will be generated for each POD for return to CONUS. Such retrograde movement requirements will include the categories of: casualties, captured enemy equipment, US equipment not repairable in theater, noncombatant emergency evacuation, and prisoners of war. Rates used for generation of such retrograde movement requirements will be easily changed by the analyst.

TEST OBJECTIVE: Confirm that GDAS has the capability to dynamically generate, schedule, and transport medical evacuation patients, noncombatants, and retrograde cargo based on the number of soldiers in a theater.

TEST PROCEDURES: To be determined. The GDAS SDS and program design language do not describe any mechanism for moving cargo from theaters to CONUS. The only evidence that such cargo has been considered is in the GDAS data dictionary. The description of the Cargo Category data field (table CARGOCAT) indicates that movement requirements may include Medivac and NEO cargo categories.

DATA COLLECTION REQUIREMENTS: No supporting data available in GDAS at this time.

EVALUATION CRITERIA: To be determined. Criteria should be based on the methodology and factors used for dynamic generation of medical evacuation, NEO, and retrograde cargo.

GDAS IV&V TEST CASE # 3-64

IV&V ISSUE: Weighting of cargo movement versus lift asset utilization.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The simulation will attempt to satisfy the following goals:

- o deploy units to arrive not later than (NLT) the unit's RDD;
- o deploy resupply cargo to arrive no later than (NLT) the resupply's RDD, and not earlier than the unit itself;
- o maximize utilization of lift capacity.

The analyst will have the option of altering scheduling priorities by modifying the simulation RDD.

TEST OBJECTIVE: Confirm that GDAS can be used to analyze both transportation system capacity and lift resource allocation studies.

TEST PROCEDURES: To be determined. The SDS (para 5.15) provides a general description of cost (penalty) factors, benefit factors, and other parameters designed to control these GDAS functions. The test procedures will be established by one of two methods:

- o If sufficient detail regarding the use of scheduling guidance and control parameters is provided in the Detailed Algorithm Specification and User's Manual to be delivered by the model developers, test procedures will be based on that information.
- o An iterative testing process can be used, first executing a simulation experiment designed to screen the effects of the factors identified as scheduling guidance and control parameters. The results of the screening experiment will then provide a basis for selecting and developing further tests.

DATA COLLECTION REQUIREMENTS: To be determined. The primary data required for this test will be model control parameters, cargo delivery profiles, and lift asset utilization.

EVALUATION CRITERIA: To be determined. Evaluation of results from this test will ultimately depend on the GDAS capability for analysts to control the balance between achieving closure goals and maximizing lift resource utilization.

GDAS IV&V TEST CASE # 3-65

IV&V ISSUE: Vary the cargo priority among theaters.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.15.

REQUIREMENT STATEMENT: The major criteria for sorting cargos is the Target Lift Date (TLD) calculated during the planning. Among all cargos with the same TLD, the analyst can set the movement priority to ensure the most important movements have the best chance of obtaining transportation resources.

TEST OBJECTIVE: Confirm that GDAS allows analysts to specify a desired priority order for movement requirements destined to a particular theater.

TEST PROCEDURES: Select or generate a scenario that results in a quantity of late cargo to more than one theater. Query tables NODE (fields Node Name, Theater), DESTIN (field Destination), and REQUIRE (field Destination) to identify all movement requirements destined to one of the theaters. Edit the Priority Order field in table REQUIRE so that a requirement that was late has a higher priority than some requirement that was delivered on time within the selected theater. Rerun the scenario to determine whether the priority changes affected only the selected theater.

DATA COLLECTION REQUIREMENTS: Cargo delivery dates and cargo lateness by theater.

EVALUATION CRITERIA: Cargo delivery dates for the selected theater should result in earlier delivery (less lateness) of the requirement set to higher priority. Results for other theaters should not be affected.

GDAS IV&V TEST CASE # 3-66

IV&V ISSUE: Effectiveness of the "look ahead" scheduling window.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.15.

REQUIREMENT STATEMENT: The primary variable for setting a "look ahead" capability is the scheduling horizon. The scheduling horizon defines a moving time window relative to the current simulation day in the model, such that only cargos having a TLD within the scheduling horizon time window are considered for scheduling on that simulation day. When the TLD of a cargo falls within the scheduling horizon, the model evaluates a large number of candidate ship or aircraft assignments for that cargo.

TEST OBJECTIVE: Confirm that GDAS allows analysts improve measures such as lift asset utilization (i.e., percent fill) by extending the scheduling time window.

TEST PROCEDURES: To be determined (see page 3-64). The effectiveness of the GDAS look-ahead window in affecting either cargo delivery or lift asset utilization is probably directly coupled to the use of other scheduling guidance and control factors.

DATA COLLECTION REQUIREMENTS: Primary data for this test will include cargo delivery measures (unit closures, total delivered over time, etc.) and lift asset utilization measures (vehicle activity over time, percent fill, etc.).

EVALUATION CRITERIA: To be determined. The general criterion for this test is whether increasing the scheduler's look ahead window causes an improvement in the measure of effectiveness being examined.

GDAS IV&V TEST CASE # 3-67

IV&V ISSUE: Dynamic reallocation of sealift assets.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.6.

REQUIREMENT STATEMENT: The initial availability of a ship is defined in the SHIPLAD table either from a single start node or based on externally calculated availabilities at individual ports (if a ship availability date is not specified for a given seaport, the availability is calculated from the nearest port that does have an availability date).

TEST OBJECTIVE: Confirm that excess sealift capacity at one port can be dynamically reallocated to another port in GDAS.

TEST PROCEDURES: To be determined. The GDAS SDS and data dictionary do not describe any capability to reallocate ships among ports.

DATA COLLECTION REQUIREMENTS: To be determined. The necessary data fields may be defined in a later version of the GDAS Data Dictionary.

EVALUATION CRITERIA: To be determined. Criteria should be based on the methodology and factors used to accomplish dynamic reallocation of sealift assets.

GDAS IV&V TEST CASE # 3-68

IV&V ISSUE: Appropriate measures for compartment loading.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.6.

REQUIREMENT STATEMENT: Compartment types are used to specify vehicle capacity, stow factors, and the units of measure for defining capacity limits; e.g., for sealift the compartments generally have a single limiting capacity measure (mton or TEU for container compartments, sq. ft. for RO/RO compartments, cBbl for POL compartments, etc.) and for airlift, the compartments have multiple, simultaneous limiting capacity measures based on density factors (mton, sq. ft., pax).

TEST OBJECTIVE: Confirm that GDAS loads each available ship compartment with the appropriate quantity of cargo according to the cargo measure, compartment measure, and stowage factor.

TEST PROCEDURES: Identify a frequently used compartment type in table CARGLOAD. Link with tables CARGO and CATMEAS to get the basic measures for the selected cargos. Link CARGLOAD with SHIPCAP to get the compartment measure and capacity. Check tables STOWFACT and STOWPEN to get the stow efficiency for each cargo category loaded in the selected compartment type. Compare basic cargo quantities loaded against the compartment capacity (adjusted by the stow factor). (QUESTION: Where can we find the conversion formulas if measures are mixed? Tables MEASURE and MEASCLAS don't have them.)

DATA COLLECTION REQUIREMENTS: Use queries in any existing GDAS scenario to obtain the data described in the test procedures.

EVALUATION CRITERIA: The loaded cargo quantities should not exceed the vehicle compartment capacity.

GDAS IV&V TEST CASE # 3-89

IV&V ISSUE: Multimodal shipment of matching requirements.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.2.

REQUIREMENT STATEMENT: The model design explicitly accounts for the coordination of multiple, interdependent movements which are characteristic of DoD intermodal transportation, including cargos which are related by precedence sequencing (e.g., a multimodal staged movement in which an airlift leg depends on a prior sealift leg), or assembly dependency (e.g., multiple air/sea or POMCUS movements which must marry up at a marshalling or staging location before moving forward), or balanced force links (e.g., CS/CSS/supply movements which are assigned to support a combat unit).

TEST OBJECTIVE: Confirm that GDAS has the capability to schedule interdependent cargos for synchronized arrivals at destination.

TEST PROCEDURES: Output data from an existing GDAS scenario can be used to perform this test. Query table RPTREQ to identify movement requirements that have both cargo and PAX with the same RDD. Link RPTREQ with tables CARGO and RPTITIN to get the cargo delivery dates for all cargos associated with each selected requirement.

DATA COLLECTION REQUIREMENTS: Required data is described in the test procedures.

EVALUATION CRITERIA: Cargo and PAX belonging to the same movement requirement should be delivered to destination on the same date.

GDAS IV&V TEST CASE # 3-70

IV&V ISSUE: Hourly time step for aircraft activities.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The model will be designed with the following functional capabilities: attrition, convoying, canals, mode selection, tracking of individual ships by hull number, ship transport time step in days, **air time step in hours**, etc.

TEST OBJECTIVE: Confirm that GDAS loads/unloads aircraft and simulates their travel in hourly time increments.

TEST PROCEDURES: Not applicable. GDAS time outputs are in units of days only. Hourly activities cannot be confirmed from the available output data.

DATA COLLECTION REQUIREMENTS: Not applicable. Hourly time outputs are not available.

EVALUATION CRITERIA: Not applicable. Hourly time outputs are not available.

GDAS IV&V TEST CASE # 3-71

IV&V ISSUE: Constrained aircraft throughput at airports.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Each facility has cargo or vehicle throughput measures based on facility type and transport mode, e.g., max cargo tonnage per day, max number of sorties or vehicles per day, and maximum on ground (for airlift) or in berth (for sealift).

TEST OBJECTIVE: Confirm that GDAS limits the number of aircraft per day using an airport facility.

TEST PROCEDURES: Query table STOP in any GDAS scenario to find an airport facility that is heavily used. In table FACILITY, change the Max Vehicle Arrivals/Hour to two for this airport. Rerun the model and check table STOP again to determine whether the vehicle throughput constraint was effective.

DATA COLLECTION REQUIREMENTS: Get the facility node, vehicle arrive day, and vehicle depart day from table STOP. Get the facility operating hours/day from table FACILITY.

EVALUATION CRITERIA: The number of aircraft arrivals on a single day should not exceed the product of operating hours times arrivals/hour.

GDAS IV&V TEST CASE # 3-72

IV&V ISSUE: Hourly time step for sealift activities.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The model will be designed with the following functional capabilities: attrition, convoying, canals, mode selection, tracking of individual ships by hull number, **ship transport time step in days**, air time step in hours, etc.

TEST OBJECTIVE: Confirm that GDAS can represent ship activities with one hour time increments when desired.

TEST PROCEDURES: Not applicable. GDAS time outputs are in units of days. It is not possible to confirm hourly activities using the available data.

DATA COLLECTION REQUIREMENTS: Not applicable.

EVALUATION CRITERIA: Not applicable.

GDAS IV&V TEST CASE # 3-73

IV&V ISSUE: Constrained ship throughput at seaports.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.2.

REQUIREMENT STATEMENT: Each facility has cargo or vehicle throughput measures based on facility type and transport mode, e.g., max cargo tonnage per day, max number of sorties or vehicles per day, and maximum on ground (for airlift) or in berth (for sealift).

TEST OBJECTIVE: Confirm that GDAS limits the number of ships per day using a seaport facility.

TEST PROCEDURES: Query table STOP in any GDAS scenario to find a seaport facility that is heavily used. In table FACILITY, change the Max Vehicles in Facility to two. Rerun the model to determine whether the vehicle throughput constraint was effective. (See test 2-31.)

DATA COLLECTION REQUIREMENTS: Get the facility node, vehicle arrive day, and vehicle depart day from table STOP.

EVALUATION CRITERIA: There should not be more than two ships at the selected seaport facility on any one day.

GDAS IV&V TEST CASE # 3-74

IV&V ISSUE: Traceability of individual lift assets.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 5.16.

REQUIREMENT STATEMENT: Various MOEs will be incorporated into the GDAS prototype through the development of useful queries which are enhanced by graphical illustrations. These include detailed ship itineraries including port visits and cargo load/unload activities; detailed port activities including ship arrivals and cargo load/unload dates; and summary totals of ships and aircraft used.

TEST OBJECTIVE: Determine whether the GDAS FD output requirements for lift asset utilization are met by GDAS output.

TEST PROCEDURES: Examine data in tables RPTITIN, RPTREQ, RPTVEHDY, and RPTVEHTYPE to determine whether all data required by the FD is present. (See test 2-49.)

DATA COLLECTION REQUIREMENTS: Output data from any GDAS simulation can be used to perform this test.

EVALUATION CRITERIA: All required data should be easily accessible to the analyst.

GDAS IV&V TEST CASE # 3-75

IV&V ISSUE: Interface with existing force models.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The DBMS will be structured to permit interface with related existing and future models.

TEST OBJECTIVE: Confirm that GDAS has the capability to produce output files that are formatted for direct transfer to FORCEM and CEM.

TEST PROCEDURES: This test can be performed from any GDAS scenario output. The GDAS SDS description of the Database Subsystem (para 4.2.1) states that the Utilities Menu, accessed from the GDAS Main Menu, has an export capability that will automatically generate queries and format output files for input into CAA combat models. First the Transfer utility must be used to transfer data from a scenario to a REFERENCE directory. Then the FORCEM or CEM Export utility can format output files for input into the combat models.

DATA COLLECTION REQUIREMENTS: Obtain a specification of the content and format of GDAS data required for input to FORCEM and to CEM. Export GDAS output for each model to be compared with the data specifications.

EVALUATION CRITERIA: The GDAS export files should precisely match the FORCEM and CEM data specifications.

GDAS IV&V TEST CASE # 3-76

IV&V ISSUE: Selectable chart type for GDAS output.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The graphics capability will be linked with the DBMS and will allow the user to select chart type to include line, pie, and bar charts.

TEST OBJECTIVE: Determine the degree of flexibility available to analysts while preparing charts in the GDAS interactive graphics package.

TEST PROCEDURES: To be determined. The GDAS SDS does not contain sufficient information on the GDAS interactive graphics package to develop test procedures.

DATA COLLECTION REQUIREMENTS: To be determined. Almost any set of data in GDAS output could be selected for this test.

EVALUATION CRITERIA: The GDAS interactive graphics package should allow analysts to select the type of chart used to present data as described in the requirement statement.

GDAS IV&V TEST CASE # 3-77

IV&V ISSUE: Capability to add text to charts.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 4.2.2.

REQUIREMENT STATEMENT: The presentation graphics package will provide options for screen definitions and attributes, hardcopy output, and saving the charts for full customization

TEST OBJECTIVE: Confirm that analysts can annotate GDAS charts with text in the interactive graphics package.

TEST PROCEDURES: Use data from an existing GDAS scenario to plot a chart and annotate the chart with inserted text. Detailed information on use of the interactive graphics package is needed to develop detailed test procedures.

DATA COLLECTION REQUIREMENTS: Data from any GDAS scenario can be used for this test.

EVALUATION CRITERIA: The GDAS interactive graphics package should allow the user to insert text onto a chart while it is being built or after it is completed.

GDAS IV&V TEST CASE # 3-78

IV&V ISSUE: Capability to import graphics into charts.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 4.2.2.

REQUIREMENT STATEMENT: The presentation graphics package will provide options for screen definitions and attributes, hardcopy output, and saving the charts for full customization. (The Presentation Graphics Subsystem diagram in SDS Figure 4-9 indicates a capability to "insert graphics.")

TEST OBJECTIVE: Confirm that analysts can annotate GDAS charts with imported graphics in the interactive graphics package.

TEST PROCEDURES: Obtain graphics files in a format compatible with the GDAS interactive graphics package (e.g., PIC, CGM). Use an existing GDAS scenario to develop a chart and add a graphic to the chart. Detailed information on use of the interactive graphics package is needed to develop detailed test procedures.

DATA COLLECTION REQUIREMENTS: Obtain graphics files specified by CAA for insertion into a GDAS chart. Data from any GDAS scenario can be used to develop the test.

EVALUATION CRITERIA: The GDAS interactive graphics package should allow the user to insert graphics from other sources onto a GDAS chart while it is being built or after it is completed.

GDAS IV&V TEST CASE # 3-79

IV&V ISSUE: Control of chart headings, legend, and layout.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The graphics capability will allow the user to define headings, legend, layout, axis scale, labels, text, etc.

TEST OBJECTIVE: Determine the degree of flexibility available to analysts while preparing charts in the GDAS interactive graphics package.

TEST PROCEDURES: Use data from an existing GDAS scenario to develop a chart (or make a copy of an existing chart). Experiment with changes in the chart title, axis labels, legends, data symbols, etc. Save and print several versions of the chart.

DATA COLLECTION REQUIREMENTS: Data from any GDAS scenario can be used for this test.

EVALUATION CRITERIA: The GDAS interactive graphics package should allow the user to control the content, size, position, and orientation of chart headings and legends.

GDAS IV&V TEST CASE # 3-80

IV&V ISSUE: Capability to interactively preview and edit output charts.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The graphics capability will be linked with the DBMS and will allow the user to enter/edit chart data.

TEST OBJECTIVE: Confirm that the GDAS interactive graphics package allows analysts to preview a chart as it will be printed and select alternate parameters to achieve the desired data presentation.

TEST PROCEDURES: This test can be performed concurrently with test # 3-79. The changes to be made should include the chart type and data content. Printed charts should be compared with the screen preview.

DATA COLLECTION REQUIREMENTS: Use data from any existing GDAS scenario for this test.

EVALUATION CRITERIA: The GDAS interactive graphics package should provide accurate screen previews of charts to be printed.

GDAS IV&V TEST CASE # 3-81

IV&V ISSUE: Capability import and edit data for output charts.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 4.2.2.

REQUIREMENT STATEMENT: The Presentation Graphics Subsystem integrates directly with the database via the query menu functions. . . In addition, the graphics package can be used in a stand-alone mode to prepare complete customized presentations.

TEST OBJECTIVE: Confirm that GDAS allows analysts to combine any desired GDAS output data from multiple scenarios on a single chart and manipulate it for effective presentation.

TEST PROCEDURES: For test purposes it is sufficient to demonstrate that data from two GDAS scenarios can be combined on a single chart. Select an IV&V test that requires a base case run and an excursion run. Identify the data related to the MOE evaluated in the test. Enter the presentation graphics subsystem and extract MOE data from both the base case and excursion outputs. Graph the two sets of data on one chart for comparison. Use the editing features of the presentation graphics package to put the MOE data in summary form and graph the reduced data on a new chart. Detailed information on use of the interactive graphics package is needed to develop detailed test procedures.

DATA COLLECTION REQUIREMENTS: Obtain comparable output data from two GDAS runs to be plotted in a single graph.

EVALUATION CRITERIA: The user should be able to import data from any selected GDAS scenario and manipulate it in the interactive graphics package.

GDAS IV&V TEST CASE # 3-82

IV&V ISSUE: Control of chart axis scale, labels and grid lines.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The graphics capability will be linked with the DBMS and will allow the user to define headings, legend, layout, axis scale, labels, text, etc.

TEST OBJECTIVE: Confirm that the GDAS interactive graphics system allows analysts to control the presentation of graphed data in charts.

TEST PROCEDURES: This test can be performed concurrently with test # 3-79. Experiment with the scale and labels of each axis and with available grid line options to determine the degree of flexibility allowed.

DATA COLLECTION REQUIREMENTS: Document observations regarding the range of options available in formatting axis scale, labels, and grid lines.

EVALUATION CRITERIA: The user should have a flexible range of options for formatting axis scale, labels, and grid lines in output charts.

GDAS IV&V TEST CASE # 3-83

IV&V ISSUE: Spreadsheet-like manipulation of chart data.

GDAS SUBSYSTEM: Presentation Graphics.

REQUIREMENT SOURCE: GDAS FD para 3-4.d.(7) (not in SDS).

REQUIREMENT STATEMENT: The interactive graphics package will allow the user to manipulate data which drives the chart within the utility with similar capabilities to spreadsheet programs: calculate values from cells/ sets of cells, copy, delete, cut, paste cells or sets of cells, build macro commands which will perform repetitive functions on similar data sets.

TEST OBJECTIVE: Confirm that the interactive graphics package has spreadsheet-like capabilities for manipulating data.

TEST PROCEDURES: IV&V NOTE: Current GDAS development plans include use of Quattro Pro as the presentation graphics package (including stand alone use to customize graphics). Since Quattro Pro is a spreadsheet package, a separate test should not be necessary to demonstrate satisfaction of this requirement. If another package is used, test procedures would depend on the capabilities of the package.

DATA COLLECTION REQUIREMENTS: To be determined.

EVALUATION CRITERIA: To be determined.

GDAS IV&V TEST CASE # 3-84

IV&V ISSUE: Capability to view animation of a GDAS simulation.

GDAS SUBSYSTEM: Transportation Graphics.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The graphics capability will be linked with the DBMS and will allow the user to view a world map consisting of air and sea ports, channels, origins, destinations, and transportation assets.

TEST OBJECTIVE: Confirm that GDAS allows users to view animation of simulated events.

TEST PROCEDURES: To be determined. The GDAS SDS states that the Transportation graphics subsystem will have the capability to display GDAS nodes, links, and ship locations in a snapshot mode -- no animation. This capability is not available during a model run. It is accessed via the Check Results option under the Transportation Model Menu.

DATA COLLECTION REQUIREMENTS: To be determined. It should be possible to use any existing GDAS scenario for this test.

EVALUATION CRITERIA: The user should be able to view a GDAS simulation as it is occurring or write the animation to an output file for later viewing.

GDAS IV&V TEST CASE # 3-85

IV&V ISSUE: Capability add new queries to the menu system.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The capability will exist for the analyst to easily add a new type of query and/or report to the menu system. Once added, the query and/or report will be accessible by a menu selection.

TEST OBJECTIVE: Confirm that GDAS allows users to save new data queries and access them through the menu system.

TEST PROCEDURES: This test can be performed concurrently with IV&V test # 3-86 that requires an ad hoc data query. Once the query is developed, save it using the procedure provided in GDAS. Exit GDAS normally and enter again, selecting the same scenario. Select the "Use Custom Queries" option from the Query menu to find and play the saved query. (QUESTION: Should the new query be available in other scenarios?)

DATA COLLECTION REQUIREMENTS: This test can be performed with any existing GDAS scenario.

EVALUATION CRITERIA: The saved query should be available via the GDAS menu system.

GDAS IV&V TEST CASE # 3-86

IV&V ISSUE: Capability to generate ad hoc queries and reports.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: In addition to the capability of producing standard reports, the model will be supported by an independent DBMS which will allow the analyst to quickly perform ad hoc queries concerning particular model runs.

TEST OBJECTIVE: Confirm that analysts can readily retrieve, update, and display GDAS data without using the standard GDAS reports.

TEST PROCEDURES: Use the Create/Edit option under the Query menu of the Transportation Model menu. Create and execute a query to produce a result that can be compared with a standard output report. For example, all cargo and PAX quantities associated with one movement requirement can be summed by measure and compared with the input totals. (NOTE: Test 3-85 can be performed at this point.)

DATA COLLECTION REQUIREMENTS: This test can be performed using any existing GDAS scenario.

EVALUATION CRITERIA: The user should be able to generate accurate results from an ad hoc query.

GDAS IV&V TEST CASE # 3-87

IV&V ISSUE: Capability to add new reports to the menu system.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 2.2.

REQUIREMENT STATEMENT: The capability will exist for the analyst to easily add a new type of query and/or report to the menu system. Once added, the query and/or report will be accessible by a menu selection.

TEST OBJECTIVE: Confirm that users can generate new report formats and save them for later use via the GDAS menu system.

TEST PROCEDURES: To be determined. The GDAS SDS does not describe a procedure to develop new reports. Anticipate that one would first develop and save a query to tabulate the data of interest, then develop and save a report that formats the query results for output.

DATA COLLECTION REQUIREMENTS: To be determined. Almost any set of data in the GDAS output could be selected for this test.

EVALUATION CRITERIA: To be determined. The basic concept is that once a report is put into the GDAS menu system it should be available to produce similar output for subsequent model runs.

GDAS IV&V TEST CASE # 3-88

IV&V ISSUE: Output showing port operations by date and time.

GDAS SUBSYSTEM: Transportation Model.

REQUIREMENT SOURCE: GDAS SDS para 5.4.9.

REQUIREMENT STATEMENT: Each voyage or trip has an itinerary which is defined in terms of stops at ports or nodes. For each stop, the output data includes arrive day, node or port, facility type, depart day, and whether the stop is for unloading. (NOTE: Hourly output is explicitly excluded from the GDAS design.)

TEST OBJECTIVE: Confirm that GDAS has the capability to analyze the impact of port constraints on a deployment in sufficient detail to identify bottlenecks.

TEST PROCEDURES: Query table RPTITIN for all records related to a specific port facility. sum the cargo loaded and unloaded at the facility by day for comparison with GDAS summary reports showing cargo delivered. Also check facility activities in table RPTITIN against activities in table STOP for the same facility.

DATA COLLECTION REQUIREMENTS: Obtain facility activities from tables RPTITIN and STOP. Use GDAS standard cargo delivery output (by port) to compare with query totals.

EVALUATION CRITERIA: GDAS output files should give both the date and time of significant events (opening, closing, etc.).

GDAS IV&V TEST CASE # 3-89

IV&V ISSUE: Capability to archive the entire GDAS system.

GDAS SUBSYSTEM: Utility Menu.

REQUIREMENT SOURCE: GDAS SDS para 4.2.1.

REQUIREMENT STATEMENT: The "Backup" and "Restore" utilities backup and restore complete scenarios respectively. Once the analyst chooses either option, he/she is prompted for some information including the scenario name and either tape or floppy disk(s).

TEST OBJECTIVE: Save (archive) the GDAS computer programs and a selected scenario to tape or floppy disks and restore the system from the saved copy.

TEST PROCEDURES: The GDAS utility menu can be used to save a GDAS scenario, rename the scenario directories, then restore the original directory. Completeness of the restored files can be confirmed by checking storage space used and by using a file comparator utility to check the restored directories against the original directories.

Procedures for saving the GDAS computer programs are not described in the SDS. If accomplished, all GDAS directories can be renamed after the copy is saved. A file comparator can be used to check the restored directories against the original files.

DATA COLLECTION REQUIREMENTS: Print or record the storage used by the scenario and by selected individual files for comparison with the restored scenario.

EVALUATION CRITERIA: The restored scenario should match the original scenario in each comparison.

GDAS IV&V TEST CASE # 3-90

IV&V ISSUE: DBMS support of structured query language (SQL).

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: None.

REQUIREMENT STATEMENT: Applicability of this test must be determined from forthcoming GDAS documentation. The GDAS DBMS will be Paradox, but the SDS description of the DBMS is based on Ingres.

TEST OBJECTIVE: Confirm that GDAS can share or exchange data with SQL-based data bases.

TEST PROCEDURES: Not applicable. The following excerpt from the GDAS SDS indicates that GDAS cannot access files over the CAA local area network (LAN):

"Automated import and export capabilities are designed for GDAS for data transfer to/from 9-track tape or 1.2 MB floppy disks, but LAN applications or utilities to be developed by CAA for file transfer over the LAN are not part of this design."

IV&V NOTE: If a LAN capability is developed in GDAS, the Paradox DBMS used in GDAS should be able to access SQL files by adding Borland's SQL Link package (purchased separately). SQL Link translates Paradox query-by-example screens into SQL format to query remote tables (with some restrictions). Installation of SQL Link requires prior installation of one of the following servers:

- o IBM Extended Edition 1.2 Database Manager
- o Microsoft SQL Server Version 1.0 or later
- o Oracle Server 6.0.

DATA COLLECTION REQUIREMENTS: Not applicable. The need for this test must be assessed from forthcoming GDAS documentation.

EVALUATION CRITERIA: Not applicable. The need for this test must be assessed from forthcoming GDAS documentation.

GDAS IV&V TEST CASE # 3-91

IV&V ISSUE: Automatic classification marking on system output.

GDAS SUBSYSTEM: Database.

REQUIREMENT SOURCE: GDAS SDS para 3.4.

REQUIREMENT STATEMENT: Output of classified information will be automatically marked with the appropriate classification as specified by the analyst.

TEST OBJECTIVE: Produce GDAS output with the correct classification appropriately marked.

TEST PROCEDURES: Arbitrarily change the classification level of a completed GDAS run and produce randomly selected standard outputs on both screen and hard copy devices. Check that the output is correctly marked with the input classification level. (Question: Can different reports from the same scenario have different classification levels?)

DATA COLLECTION REQUIREMENTS: This test can be conducted with any existing GDAS output report.

EVALUATION CRITERIA: Output should be correctly marked with the input classification level.